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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

THE SUPPLEMENT.

An illustrated supplement to this issue of the ELECTRICAL REVIEW shows the progress in construction of the various buildings at the Louisiana Purchase Exposition as it was on May 15, 1903. This gives a good idea of the exteriors and of some interiors, as well as an idea of the general grouping. As yet no building is completed, though the Varied Industries Building is furthest advanced. Contrary to an impression which has unaccountably gained ground, the Electricity Building is also well along toward completion. This building is possibly the best proportioned and best located of all the buildings; it is centrally placed, facing the fountains, and promises to be in every respect worthy the art which it commemorates.

THE UTILITY OF PHOTOMETRY.

Only a few years ago the art of photometry came in for a good deal of ridicule and scorn from the so-called practical man. We were told that photometric measurements more than any other depended upon the observer, and that by far the greater majority of such measurements were unreliable and useless. And even when the accuracy of the work could not be questioned, it was emphatically asserted the practical value of this work was almost nothing, because the light given out by any illuminant varies so greatly with conditions, that all measurements made in a laboratory gave no indications of what might be expected in actual service. This view, however, was not accepted by all. Some took the stand that although electric lighting companies were charging for current, their real business was to furnish light, and that for this reason alone, if no other, they should have some idea of what the true output of the company was, a view which was generally held by the lamp manufacturers.

Importance of Photometry Recognized.

Not long since, two papers were read at a meeting of the American Institute of Electrical Engineers upon photometry, and the point was made that while satisfactory photometric measurements were not easy, still with proper precautions they could be made satisfactorily and with an accuracy as great as that demanded in other commercial measurements. That this subject occupies an important position at this time is emphasized by the fact that at the coming convention of the National Electric Light Association there will be two papers and one report presented on photometric subjects, giving this a prominence in the programme accorded to no other problem connected with electric lighting.

METHODS OF TRANSFORMING ALTERNATING CURRENTS INTO DIRECT CURRENTS.

The ease of transforming alternating currents from one potential to another gives this system great advantages for power services, as it enables a large district to be covered economically. But there are certain applications of electricity which require a continuous current, and which have created a demand for mechanisms which will convert alternating currents into direct currents.

Motor-Generators.

One of the earliest methods of accomplishing this transformation was to drive an alternating-current motor of any type from an alternating circuit, and by means of this motor to drive a direct-current machine, giving the desired potential. This system presents certain advantages. The voltage of the secondary circuit, supplied by the direct-current generator, is not dependent upon that of the alternating-current supply, and the direct-current circuit can be insulated completely from the high-potential alternating circuit. The system, however, necessitates the use of two machines, each of which must have a capacity equal to the demands on the direct-current circuit. There is, moreover, a double transformation—first, from electrical energy to mechanical, and back into electrical energy, which involves a double loss.

Rectifiers.

Another early type of machine consisted of a commutator driven by a synchronous motor. Since the synchronous motor keeps pace with the alternator supplying the circuit, the commutator also runs in step, so that by feeding the alternating current to the commutator by means of slip rings, the current impulses can be sorted out and supplied to the secondary circuit always in one direction, just as is done by the commutator of a direct-current dynamo. The current flow-

ing in the secondary circuit will then be constant in direction, but not necessarily constant in value, though the properties of the circuit will naturally tend to smooth out inequalities, and produce a current wave somewhat similar to that supplied by the early types of arc machines. The apparatus required by this system is small, as the only work the motor need do is to overcome mechanical friction; but there is more or less difficulty in avoiding sparking of the commutator, and the alternating current supplied to this must first be transformed down to the proper potential, this making a transformer necessary when a change in voltage is also desired.

Synchronous Converters.

Another type of machine, which to the engineer is very beautiful, is the synchronous or rotary converter. In the motor-generator system described above either an induction motor or a synchronous motor may be used. Now, since this synchronous motor may be nearly identical in design with a direct-current machine, it can be used as a direct-current generator by supplying it with a suitable commutator. We then have one machine which may act either as an alternating-current motor or a direct-current generator; and if it will act as either, why will it not act as both at the same time? This is just what the synchronous converter does, and although the peculiar characteristics of this machine allow certain refinements in design to be made, we may still think of it as a direct-current generator supplied with slip rings. The alternating current is first transformed down to the proper voltage, and then supplied to this machine to drive it as a synchronous motor. From the same winding, by means of the commutator, a direct current may be drawn. In fact, the machine may be looked upon as a perfect rectifier. The voltage given by the direct-current side is constant, but will, of course, be affected by changes in the voltage of the alternating-current circuit. The machine is highly efficient, but must have a capacity equal to that called for by the direct-current side. This is the type of machine used so largely in railway work.

Leblanc's Converter.

Another type of converter, invented by Maurice Leblanc, consists of a peculiarly wound ring transformer. This is connected to a stationary commutator, upon which revolving brushes, driven by a small synchronous motor, press. The winding is supplied by polyphase currents which set up a revolving field, and the brushes revolving synchronously collect a continuous current at a constant voltage. This machine differs from the other type of synchronous converter by having the armature and field combined; and its brushes, instead of being fixed, are driven by a small auxiliary motor.

Stationary Transformers.

In the methods just considered, revolving mechanisms are used. There are, however, other ways of obtaining continuous, or at least unidirectional, currents from alternating circuits, without employing revolving apparatus. One type, which is not new, is known as the electrolytic rectifier, and depends upon the property of certain metals of allowing current to flow to them from a solution, but presenting a considerable opposition to a flow in the opposite direction. Thus, a cell constructed of a plate of aluminum, a solution of amonium phosphate, and a plate of iron will allow a current to flow from the aluminum to the iron with but a slight loss, but will allow no appreciable current to flow in the opposite direction, unless the potential across the cell is forty volts or more. This apparatus may be used as an electric valve. Attempting to pass an alternating current through it will cut out every other half wave, and transmit a series of impulses all having the same direction. By a proper combination of four or more cells, the second half wave may also be sent through the same circuit, and we then get a continuous current similar to that supplied by a mechanical rectifier. The apparatus is simple, cheap, noiseless, but is rather inefficient.

Cooper Hewitt Vapor Converter.

The newest type of rectifier, and one which is full of possibilities, is the mercury vapor converter. The behavior of this apparatus is very similar to the electrolytic rectifier, in that the peculiar action of the mercury electrode allows current to pass through the apparatus in one direction only. This mechanism can be used with a three-phase supply, and will deliver a practically constant current. The efficiency is very good with commercial voltages. The apparatus is exceedingly simple, requires no attention whatever after being started, and is inexpensive.

The Rectifying Arc.

There is also another method of rectifying an alternating current, though it promises to be of little commercial value. If one electrode of an alternating current arc is split into two parts, insulated from each other, and the pole of a magnet be brought up to the arc, the reaction between the magnet and current will be such as to cause the positive half waves to flow through one side of the compound electrode, while the negative half waves will take the other course. This method, while interesting, is inefficient, though it might find application in the electric furnace.

VARIOUS KINDS OF ELECTRICAL CONDUCTION.

An interesting paper by Herr G. Beinschke was published in a recent issue of the *Physikalische Zeitschrift,* in which the author describes the splitting up of an alternating current into two unidirectional currents by means of an electromagnet. The effect was produced by substituting two carbons for one electrode in an electric arc. Current was supplied to this arc by an alternating circuit, two lines being run to the two parts of the compound electrode. By placing one pole of the magnet behind the arc, this split up the alternating current so that half waves having one sine only passed through each part.

Other Methods Not Successful.

The author attempted to obtain the same result in other ways, by substituting a sheet of metal, an electrolytic cell, a mercury vapor arc for the carbon arc, but without success, and the author then calls attention to the interesting phenomena as they seem to indicate that there are

four different kinds of electrical conduction, the carbon arc, metallic, electrolytic and mercury vapor.

LOCATING A LONG-DISTANCE HIGH-TENSION TRANSMISSION SYSTEM.

A recent issue of one of our esteemed British contemporaries gives a brief notice of a high-tension transmission system installed at "Buchanan, U. S. A.," from which power is transmitted fourteen miles to "South Bend," presumably also in U. S. A.

Locating the Station.

Being somewhat interested in high-tension transmission systems, we attempted to locate Buchanan, and for this purpose consulted the Century atlas, but our surprise was only equal to our discomfort to find that there were twelve Buchanans, U. S. A. Since, however, this town is located fourteen miles from a South Bend, it seemed possible that by locating the latter town, we could decide at which Buchanan the plant was installed. Unfortunately, again, the same atlas tells us that there are eight South Bends in the United States of America, so that the only resource left to us was to pick out of the ninety-six possible combinations that particular one in which a certain Buchanan and a South Bend were fourteen miles apart.

Preliminary Survey.

For convenience we made two columns of the various Buchanans and the South Bends which are here given:

Buchanan, Cal.	Southbend, Ark.
Buchanan, Ga.	South Bend, Ind.
Buchanan, Ky.	Southbend, Minn.
Buchanan, Mich.	Southbend, Neb.
Buchanan, Mo.	South Bend, Pa.
Buchanan, Neb.	South Bend, Tex.
Buchanan, N. J.	Southbend, Wash.
Buchanan, N. C.	South Bend, Wyo.
Buchanan, N. D.	
Buchanan, Pa.	
Buchanan, Tex.	
Buchanan, Va.	

A Systematic Search.

Examining this list shows that there are three states, each containing a Buchanan and a South Bend; but in no case are the towns found within fourteen miles of each other. Pennsylvania comes nearest to it, as here the distance is only seventy-five miles; the Nebraska combination shows 240 miles, while in Texas 260 miles separate the towns.

Unsuccessful Combinations.

Having failed in this way we next tried to select combinations of adjacent states, of which several are possible. The best combination here was that of Minnesota and North Dakota, but an air line between the two towns measures 230 miles. The Missouri-Arkansas combination gives 240 miles. The Indiana-Kentucky combination and the Texas-Arkansas combination each gives a distance of 300 miles, and that of New Jersey-Pennsylvania gives 400 miles as separating the two towns.

A Disheartening Breakdown.

Having exhausted this set of combinations, the next to be tried was that in which but one state lay between the two states containing the towns; but as no state in U. S. A. is only fourteen miles across, this scheme failed, and our whole search has been in vain. The only ways left to us to get out of the difficulty are, to either get a new atlas or to give it up, and much to our regret we have been obliged to follow the latter course for the time being.

A YEAR OF PROGRESS IN THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual meeting of the American Institute of Electrical Engineers, which was held in New York city on May 19, brought out the progress which was made during the last fiscal year. The membership has increased forty-four per cent, and several new and important lines of work have been taken up which will increase the usefulness of this organization. This has not been done without an increase in the expense, but the income of the Institute has been more than enough to take care of this.

Progress Toward an Engineering Building.

The progress made toward accepting Mr. Carnegie's gift for an engineering building has already been substantial. Subscriptions for securing the site amounting to $13,000 were announced.

New Officers.

The officers who have been elected for the ensuing year are all of them men who are deeply interested in the welfare of the Institute, and all may feel assured that the substantial progress which has been made during the past two years will be carried on earnestly and enthusiastically.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION'S CONVENTION.

The twenty-sixth convention of the National Electric Light Association will be held at Chicago from May 26 to May 28. An excellent programme has been drawn up both as regards business and social meetings.

An Excellent Programme.

The programme shows that a broad field will be covered by the papers and reports presented. For instance, one paper will discuss boiler and furnace efficiencies, and another tactful relations with customers; a third will consider fundamentals of photometry, and a fourth will consider direct heating. Among the list of officers are the names of some widely known engineers as well as several well-known university professors. The list of committee reports also shows that a wide field has been investigated. It is reported that the question box will be a particularly valuable feature at this convention.

A Successful Meeting Anticipated.

The National Electric Light Association is one of the oldest and strongest electrical societies. It occupies a prominent position and its conventions, without exception, are important and interesting. The convention this year promises to be particularly so, as the officers of the association have been unremitting in their interest and activity to make the Chicago meeting surpass all previous ones.

RELATIVE INTELLIGENCE.

The following statement, which appears in a recent number of the *Gas Engine*, is interesting:

A horse being "broken in" to the saddle became fractious at the noise and the sight of a street car, but instantly quieted down when turned toward an approaching automobile, only to rear and plunge when again headed toward the street car! The incident was commented on by all observers.

The behavior of this horse was certainly remarkable, and in striking contrast with that of a group of children who were playing upon the sidewalks of one of our large cities, and noticing the approach of an automobile, took refuge in a trolley car which happened to stop opposite them.

Design of Electric Water Power Stations.

By Alton D. Adams.

WATER-WHEELS must be located at some elevation between that of head and tail water. With horizontal shafts and direct-connected wheels and generators the main floor of the station is brought to the level of the wheels. This is much the most general type of construction and was followed in the Massena, Sault Ste. Marie, Cañon Ferry, Colgate, Electra, Santa Ana, and many other well-known water power stations. If horizontal shafts are employed for wheels and generators with belt or rope connections between them the floor of the generator room may be elevated a number of feet above the wheels. This difference of elevation is usually provided for either by upper and lower parts of the same room, or by separate rooms one above the other and a floor between them. A two-story construction of this latter sort was frequently adopted in the older water power stations, and good examples of it may be seen in connection with the electrical supply system at Burlington, Vermont, and the Indian Orchard station of the Springfield, Mass., system. Vertical wheel shafts make the elevation of the main or generator floor of a station independent of that of the wheels, and thus give the highest degree or security against high water. After the vertical wheel shaft reaches the generator room, it may be geared to a horizontal shaft that has one or more dynamos directly mounted on it, or drives dynamos through belts or ropes. Belt driving in this way, from horizontal shafts connected by bevel gears with vertical wheel shafts, is not uncommon in the older class of water power stations. Generators mounted singly or in pairs on horizontal shafts that are driven by gearing on vertical wheel shafts have seldom been adopted, but seem to offer a desirable method of connection in cases where vertical wheels are necessary and the cost of generators must be kept at a low figure. With this method of driving the generators can be designed for any economical speed.

The most desirable method of driving generators with vertical wheels, where the expense is not too great, is the direct mounting of each generator on the upper end of a wheel shaft. This method of connection not only requires a special type of generator, but may put serious limits on its speed. In general, the peripheral speed of a pressure turbine should be about seventy-five per cent of the theoretical velocity of water issuing under a head equal to that at which the wheel operates in order to give the best efficiency. The rotative speeds of turbines, operating under any given head, should thus increase as their capacities and diameters decrease. Because of these principles it is the common practice with horizontal wheels to mount two or more on each shaft to which a generator is direct-connected in order to obtain a greater speed of rotation than could be obtained with a single wheel of their combined power. Thus, at Sault Ste. Marie the horizontal shaft on which each 400-kilowatt generator is mounted is driven at 180 revolutions per minute by four turbines under a head of about twenty feet. At Massena the head of water is fifty feet and each 5,000-horse-power generator is driven at 150 revolutions per minute by six turbines on a horizontal shaft. Vertical turbines are frequently mounted singly on their shafts, as was done in the hydroelectric plant at Oregon City on the Willamette River, and this practice gives speeds that are too low for direct-connected dynamos of moderate cost, unless the head of water is unusually great. At the Oregon City plant the head of water is only forty feet, and yet a single forty-two-inch turbine was mounted on the vertical shaft that drives each generator.

The most notable example of direct-connected generators and vertical turbines is that at Niagara Falls, where twenty-one generators of 5,000-horse-power each are mounted at the tops of as many vertical wheel shafts. Each shaft in the Niagara stations is driven at 250 revolutions per minute by a pair of turbines, one above the other. The maximum head between the water in the Niagara canal and that in the tunnel which forms the tail-race is 161 feet. On ten shafts the centres of the wheel cases are 136 feet below the level of water in the canal, and no draft tubes are used.

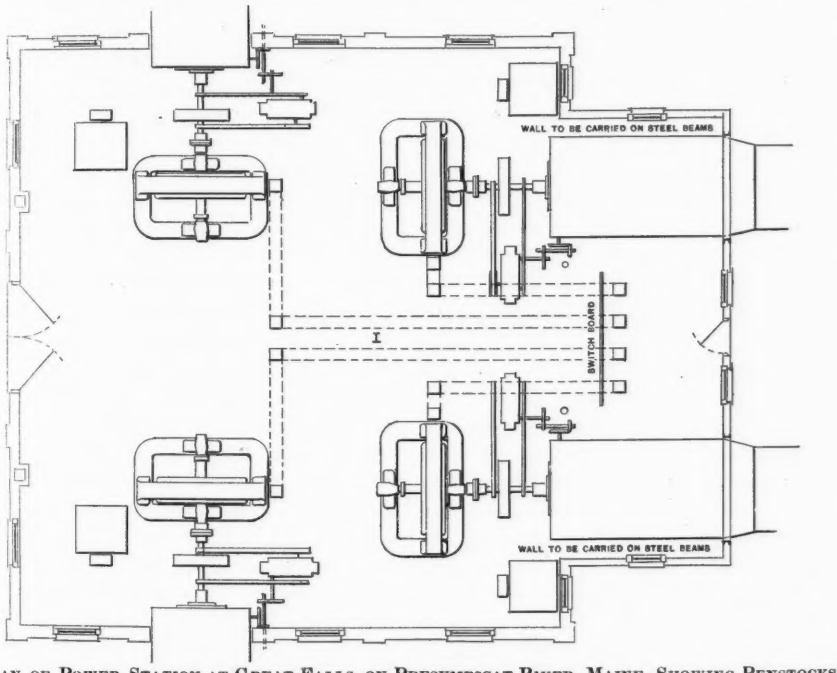
The eleven pairs of wheels at the second Niagara power-house have their centre line 128.25 feet below the canal level and a draft tube for each pair of wheels extends to a point below the tail water level. Even with these exceptional heads at Niagara Falls it was necessary to use a pair of wheels on each shaft in order to get the speed of 250 revolutions per minute. It is entirely practicable to use more than a single pair of turbines on the same vertical shaft, as is shown at the Hagneck station on the Jura, in Switzerland, where the head of water is about twenty-one feet and four turbines are mounted on each vertical shaft. The combined capacity of these four wheels on each shaft is 1,500 horse-power and its speed is 100 revolutions per minute. At the top of each shaft an 8,000-volt generator, with external, revolving magnet frame is mounted. The use of four wheels per vertical shaft presents no great difficulty and should be resorted to more frequently in the future.

For horizontal, direct-connected turbine wheels and generators the nearly uniform practice is to locate the generators in a single row from one end of a station to the other, and this brings the turbines into a parallel row. On this plan the shaft of each connected generator and its group of turbines sets at right angles to the longer sides of a station and approximately parallel with the direction in which water flows to the wheels. The typical water power station with direct-connected units is thus a rather long, narrow building into which water enters on one side through penstocks and leaves on the other through tail-races. Such stations usually set with one of the longer sides parallel to the river into which the tail water passes and between this river and the canal or pipe line. At Massena the electric station occupies the position of a dam between the end of the power canal and the Grass River, being about 150 feet wide and 550 feet long. Canal water entering this station passes through its wheels to the river under a head of about fifty feet. A similar construction was followed at Sault Ste. Marie, where the power station separates the end of the canal from the St. Mary's River. This station is 100 feet wide, 1,368 feet long and contains eighty sets of horizontal wheels, each set being connected to its own generator, and through these wheels the canal water passes under a head of approximately twenty feet. Ten generators are placed in line at the Cañon Ferry station which is 225 by 50 feet inside, and each generator is driven by a pair of horizontal wheels under a head of thirty feet. This station sets between a short canal and the Missouri River, near one end of the dam. Passing from water heads of less than fifty to those of several hundred or even more than 1,000 feet, the general type of station building remains about the same, but there is an

important change in the arrangement of direct-connected wheels and generators. With these high heads of water, wheels of the impulse type, to which the water is supplied in the form of jets from nozzles, are employed. These jets pass to the wheels in planes at right angles to their shafts, instead of flowing in lines parallel to these shafts like water to turbines. The shafts of impulse wheels and their direct-connected generators are consequently arranged parallel with the larger instead of the shorter sides of their stations. This plan results in long, narrow stations with water entering on one and leaving at the other of the longer sides, just as in the case of direct-connected turbines under moderate heads. Stations with direct-connected impulse wheels are even longer for a given number and capacity of units than are stations with pressure turbines. Colgate powerhouse, on the North Yuba River, contains seven generators, each direct-connected to an impulse wheel and shafts all parallel to its longer sides. This station is 275 feet long by 40 feet wide, and the water which enters one side by five iron pipes, thirty inches each in diameter, under a head of about 700 feet, is discharged from the other side into the river.

At Electra station on the Mokelumne River five pairs of impulse wheels are direct-connected to five generators, each unit having its shaft diagonal with the walls of the building, in order to reduce the angles in pipes that deliver water to the wheels under a head of 1,450 feet. The ground plan of the generator room at this station is 40 by 208 feet. The power station on Santa Ana River, whence energy is transmitted eighty-three miles to Los Angeles, measures 127 feet long and 36 feet wide inside, and contains four generating units in line, each of which consists of a direct-connected dynamo and impulse wheel, with shafts parallel to the longer sides of the station. Jets driving the wheels in this station are delivered under a head of 728 feet minus the loss by friction in a penstock 2,210 feet long.

Both of the Niagara plants, with vertical wheels far below the stations in rocky flumes, are long and narrow and have their generators in a single row. The later of these two stations has a ground area of approximately 72 by 496 feet outside, and contains eleven generators all in line. From these examples it may be seen that the prevailing type of electric water power station, whether designed for horizontal or vertical wheels of either the pressure or impulse type, is wide enough for only a single row of generators and wheels, and has sufficient length to accommodate the required number of units.



PLAN OF POWER STATION AT GREAT FALLS, ON PRESUMPSCAT RIVER, MAINE, SHOWING PENSTOCKS ARRANGED ON THE SIDES OF BUILDINGS.

A few modern stations that depart from this general plan will be found, as that at Great Falls, on the Presumpscat River, whence electrical supply for Portland, Me., is drawn. This station sets about forty feet in front of the forebay end of the dam, and two penstocks enter the rear wall, while the other two enter one each through two of the remaining opposite sides. Of the four generators, with their direct-connected wheels, two are arranged with parallel shafts, while the other two have their shafts in line and at right angles to the lines of the former two. The station containing these generating sets has a floor area of 55 by 67.5 feet.

Modern electric stations driven by water power are usually but one story in height and are clear inside from floor to roof, save for cranes and roof trusses. This construction may be seen in the Niagara, Spier Falls, Cañon Ferry, Colgate, Electra, Santa Ana River and many other notable plants. In spite of this one-story style of construction, the electric stations reach fair elevations because of the necessity for head room to operate cranes in placing and removing generators. At Garvins Falls, on the Merrimac River, the electric station contains generators of 650 kilowatts each and the distance from floor to the lower cords of roof trusses is twenty-seven feet. In the station at Red Bridge, on the Chicopee River, where generators are of 1,000 kilowatts capacity each, the distance between floor and the under side of roof beams is 30.66 feet. Between the floor and roof trusses at the Birchem Bend station, on the river last named, the distance is 26.25 feet, but each generator is rated at only 400 kilowatts. In the Cañon Ferry plant, with its generators of 750 kilowatts each, the distance from floor to roof trusses is twenty-eight feet. At the plant on Santa Ana River the 750-kilowatt generators, being connected to impulse wheels, operate at 300 revolutions per minute, have relatively small diameters and are mounted over pits in the floor so that their shaft centres are only about two feet above it. By these means the distance from floor to roof trusses was reduced to 18.25 feet. All these examples of elevations between floors and roof supports are for stations with direct-connected generators and horizontal wheels. In the new Niagara station, where generators of 3,750 kilowatts each are mounted on vertical wheel shafts that rise from the floor, the distance between the floor and roof trusses is 39.5 feet.

Electric stations driven by water power are now constructed almost entirely of materials that will not burn; that is, stone, brick, tile, concrete, cement, iron and steel. Stone masonry laid with cement mortar is very generally employed for all those parts of the foundations that come in contact with the tail water. For subfoundations bedrock is very desirable, but where this can not be reached piles

are driven closely and their tops covered with several feet of cement concrete as a bedding for the stone foundation. Where stone is plenty or bricks hard to obtain, the entire walls of a water power station are frequently laid entirely with stone in concrete mortar. If bricks can readily be had they are more commonly used than stone for station walls above the foundations. Concrete formed into a monolithic mass is a favorite type of construction for the foundations, walls and floors of water power plants in Southern California. Cement and concrete are much used for station floors in all parts of the country, and these floors are supported by masonry arches in cases where the tail water flows underneath the station after leaving the wheels. Station roofs are usually supported by steel trusses or I-beams, and slate and iron are favorite roof materials. With iron roof-plates an interior lining of wood, asbestos or some other poor conductor of heat is much used to prevent the condensation of water on the under side of the roof in cold weather. Walls of water power stations are usually given sufficient thickness of masonry to support all loads that come upon them without the aid of steel columns. In some cases where cranes do not extend entirely across their stations, one end of each crane is supported by one of the station walls and the other end by a row of iron or steel columns rising from the floor. Where the generator room of a station has its floor level below high-water mark especial care should be taken to make the walls water-proof to an elevation above this mark. As the traveling crane and the loads which it carries in erecting wheels and generators form a large part of the weight on the station walls, these walls are often reduced as much as one-half in thickness at the level of the crane, thus forming benches on which the ends of the cranes rest.

The Garvins Falls station, on the Merrimac River, rests on arches of stone masonry through which the tail water passes, and the brick walls are waterproofed to an elevation eight feet above the floor. At twenty feet above the floor the twenty-four-inch brick walls on the two longer sides are reduced to eight inches in thickness, thus forming benches each sixteen inches wide on which the crane travels. Arches of stone masonry support the twenty-four-inch brick walls of the station at Red Bridge, on the Chicopee River, and these walls on the two longer sides decrease in thickness to twelve inches at an elevation of twenty-one feet above the floor, thus forming benches twelve inches wide for the ends of the crane.

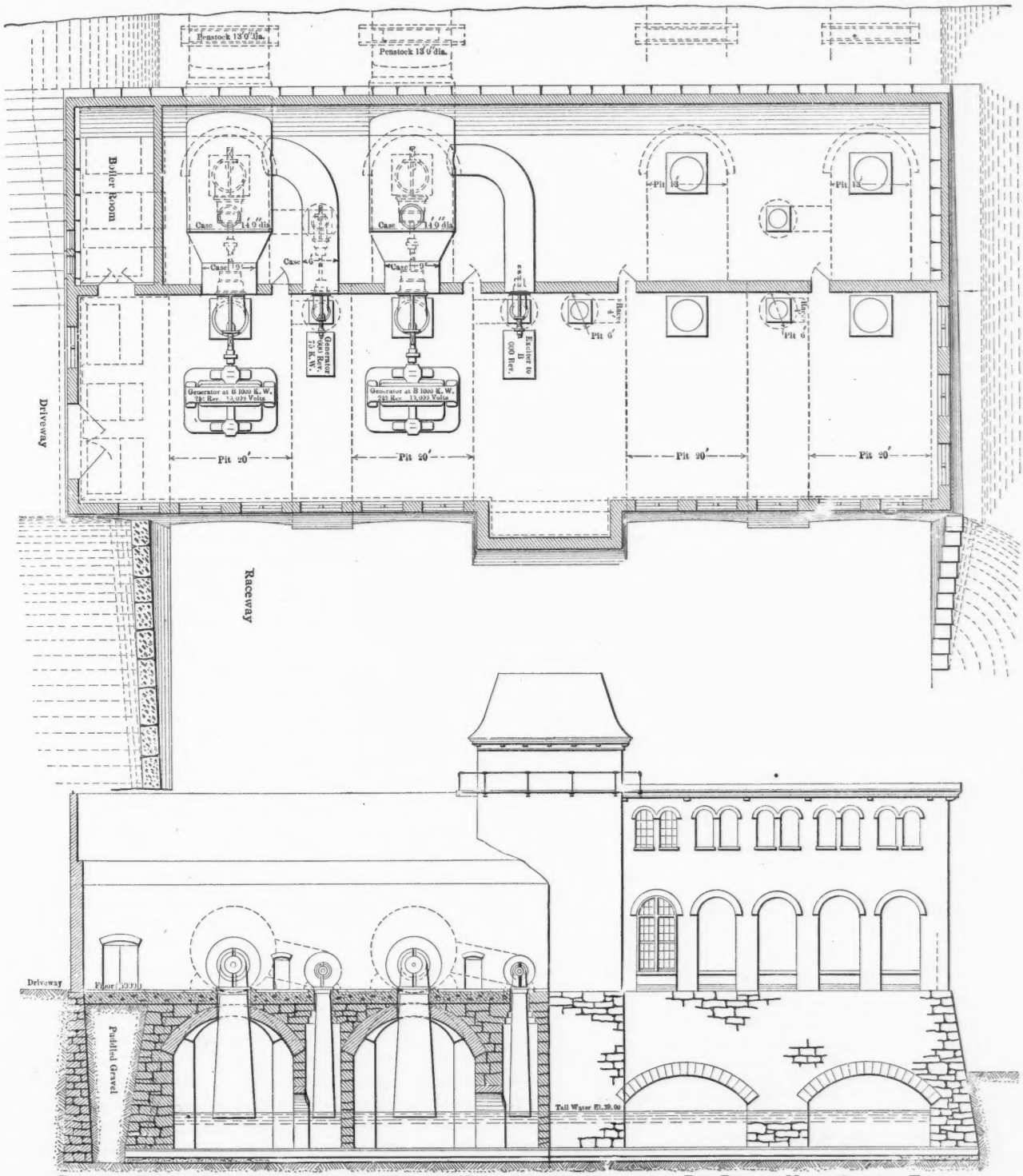
One concrete wall of the Santa Ana station is 2.5 feet thick to a distance of 13.5 feet above the floor, and then shrinks to a thickness of 1.5 feet, corresponding to that of the opposite wall, thus forming a bench twelve inches wide for one end of the crane. The other end of the crane in this case is supported by an I-beam on a row of iron columns.

It is not uncommon to locate horizontal turbines in a room separate from that occupied by the generators to which they are direct-connected, in order to protect the latter from water in the event of a break in penstocks or wheel cases. In cases of this sort the shafts connecting wheels and generators pass through the wall between them. The horizontal turbines may be located at the bottom of a canal whose water presses against the wall through which the wheel shafts pass, or they may be contained in iron cases at the ends of penstocks. In this latter case an extension of the station is often provided for a wheel-room to contain these cases. Such wheel-rooms are long, narrow, low-roofed and parallel to the main rooms of their stations. The floors of these wheel-rooms are at nearly the same levels as the floors of generator rooms, but elevations of their roofs above the floors are much less than like elevations in the main parts of the stations The Garvins Falls, Red Bridge, and Apple River stations have wheel-rooms of the type just described. With impulse wheels to which water passes in plains at right angles to their shafts it is desirable, in order to avoid changes in the directions of water pipes, that direct-connected wheels and generators occupy the same room, and this is the arrangement at the Colgate, Electra, Santa Ana, Mill Creek, and many other power-houses using such equipments. The area of a wheel-room may frequently be reduced at stations operating direct-connected horizontal pressure turbines under low heads, by placing the wheels at the bottom of the canal which has one side of the station or generator room for a retaining wall. This plan was adopted at the Birchem Bend plant with a head of fourteen feet, and at the Sault Ste. Marie station where the head of water is about twenty feet. Vertical wheels direct-connected to generators must be directly underneath the main room of their station, and may be in a canal over which the station is built, in a wheel-room that forms its lower part, or in a wheel-pit and supplied with water through penstocks, as at the Niagara Falls plants.

Step-up transformers developing very high voltages are not an element of safcty in a generator room, and the better practice is to locate them in an apartment by themselves, if not in a separate building. For the Niagara Falls plant the transformers that deliver three-phase current at 22,000 volts are located in a building across the canal from the generating plant. At Cañon Ferry the transformers operating at 50,000 volts, three-phase, are located in a steel and iron addition to the power-house. Transformers at Electra station, which are intended to work ultimately at 60,000 volts, are located in an extension of the main building and are separated from the generator room by a wall. At the Santa Ana plant the 33,000-volt transformers are grouped in one corner of the generator room, but no partition separates their space from the remainder of the room. In the Colgate plant the transformers working at 40,000 volts are spaced along one of the longer sides of the station opposite to and only a few feet from the row of generators. One end of the main room in the Apple River plant is devoted exclusively to the 25,000-volt transformers, and there is a distance of about twenty-seven feet between them and the nearest generator. The highest degree of safety for transformers at these great voltages seems to require that they be located in a separate room where the floor, walls and roof are made entirely of incombustible material.

Water supplied to horizontal turbine wheels under moderate heads usually enters the station by penstocks on one side and leaves it by the tail-race on the other, but this is not true in every case. At the Birchem Bend plant, the canal in which the wheels are located being between the station and the river, water never enters or passes under the station, which has a continuous foundation. So again at the Apple River plant the single supply pipe, twelve feet in diameter and delivering water under a head of eighty-two feet, lies parallel with the greater length of the station and between it and the river. Short penstocks pass from this supply pipe into the wheel section of the power-house, and the water after passing through the wheels flows out to the river between the masonry piers that support the twelve-foot pipe. The generator section of this station has thus no water flowing under it. An interesting distinction may be noted between the conditions as to the tail water about the foundations of stations working under

low and those under great water heads. In cases of the former sort the volumes of water are relatively great and the foundations of stations are usually submerged, and much reduced in area to make room for the tail-races. Thus, the foundations of the station at Red Bridge, where there is forty-nine feet head, have nearly all of their footings under water, and of a total length of 145 feet at the top of these foundations the six-tail races underneath cut out ninety-two feet. These tail-races extend underneath both the wheel and generator rooms.



PLAN AND ELEVATION OF POWER STATION OF LUDLOW MANUFACTURING COMPANY, AT RED BRIDGE, MASS., SHOWING TYPICAL ARRANGEMENT WHEN LARGE VOLUMES OF WATER ARE HANDLED.

Where power is derived from water delivered under great head from pipe nozzles to impulse wheels, stations are usually well above the water levels of streams into which they discharge, and passages for tail water underneath the stations shrink to small tunnels through their foundations. Seven of these tunnels have a total width of less than twenty-five feet at the Santa Ana River station, which is 127 feet long, and where the head of water is 728 feet. At the Colgate plant, with its head of 700 feet, the water, at times of light load, instead of flowing out of its passages un-

derneath the station, shoots from the pipe nozzles clear across the North Yuba River on the bank of which the station stands.

In a comparison of floor areas per kilowatt of main generator capacities in electric stations using water and those using steam power, the matter of space for transformers may be entirely omitted, because the extent of this space is independent of the type or location of waterwheels, or the differences of water and steam as motive powers. Where waterwheels and their connected generators occupy separate rooms, as is often the case with turbines under low pressures, the wheel-room has a little less length, and is generally narrower than the generator room. Thus, at the Red Bridge station the generator room is 141 feet long, and the wheel-room about 127 feet, while the former is 33.33 feet and the latter twenty-four feet wide. So again at Apple River Falls the generator room is 140 by 30 feet, and the wheel-room 106 by 22 feet, the generator room in this case containing also transformers. It follows that if wheels can be located outside of the station, as in a canal, quite a reduction in its total floor area can be made, which may easily range from twenty to forty per cent. The kilowatt capacity per square foot of floor area in both wheel and generator rooms combined tends to increase with the individual capacity of the generating units. Generators on vertical shafts seem to require about as much floor space per unit of capacity as do generators on horizontal shafts. In the Red Bridge station the total capacity is 4,800 kilowatts of main generators in six horizontal units, and the area of the generator room alone is 0.96 square foot per kilowatt of this capacity. The second station at Niagara Falls has a capacity of 41,250 kilowatts in eleven generators on vertical shafts, and its floor area amounts to 0.86 square foot per kilowatt; in spite of the large capacity of each generator narrow impulse wheels of large diameter tend to economy of floor space, as in Electra station, where the room containing wheels and generators has an area of only 0.83 square foot per unit of its 10,000 kilowatts capacity. At the Colgate plant, where the total rating of generators is 11,250 kilowatts, the floor area under wheels and generators is almost exactly one square foot per kilowatt. The Santa Ana station, with a total capacity of 3,000 kilowatts, has 1.52 square feet of floor area for each unit of capacity. This last figure may be compared with the 1.72 square feet per kilowatt of generator rating for the 4,800-kilowatt station at Red Bridge, and the 1.75 square feet per unit of capacity in the 800-kilowatt plant at Birchem Bend.

All types of water power stations with direct-connected wheels and generators have much smaller floor areas per unit capacity than do steam power stations with direct-connected units. Thus, the modern steam-driven station at Portsmouth, N. H., has a plan area in engine and boiler rooms of 16,871 square feet, and its total capacity in four direct-connected units is 4,400 kilowatts, so that the area amounts to 3.82 square feet per kilowatt rating of its generators. Of this area about forty-six per cent was in the boiler room.

FLOOR DIMENSIONS FOR DIRECT-CONNECTED, HORIZONTAL WATERWHEELS AND GENERATORS AT ELECTRIC STATIONS.

Station.	Feet Long.	Feet Wide.	Number of Generators.	Total Kw. Capacity.
*Niagara, No. 2.	496	72	11	41,250
Sault Ste. Marie.	1,368	100	80	32,000
Colgate.....	275	40	7	11,250
Electra.....	208	40	5	10,000
Cañon Ferry....	225	50	10	7,500
Red Bridge.....	141	57	6	4,800
Apple River....	140 106	30 22	4	3,000
Santa Ana River.	127	36	4	3,000
Great Falls.....	67.5	55	4	2,000
Garvins Falls...	62 50	30 23	2	1,300
Birchem Bend..	56.6	26.7	2	800
Portsmouth (steam-driven)	14.4 inside, but minus 360 sq. ft.	119.66	5	4,400

*Vertical wheel shafts.
Some of these dimensions apply to the inside and some to the outside of stations. Some small projections are not enclosed.

Photographs by Rays from the Human Body.

The daily press reports that Professor Arthur W. Goodspeed, of the University of Pennsylvania, has been able to obtain photographs by means of rays emanating from the human body. A Crookes focus tube was placed within a light-proof box, in such a position that the platinum plate deflected the rays upward. This was then covered by sheets of lead, and upon the top of the lead was a photographic plate, also enclosed in a light-proof box. Upon the top of the latter box was a cylinder of brass, with a small aperture in its side. Within the cylinder were placed a ring and a copper cent, together with a piece of aluminum. With the room in complete darkness, Professor Goodspeed held his hand three inches from the aperture in the box for three minutes. The photographic plate was taken from its box, and developed, and radiographs of bodies were found upon it.

BOOK REVIEWS.

"Modern Machine Shop Tools." William H. Van Dervoort. New York. Norman W. Henley & Company. Cloth. 552 pages. 6 by 9 inches. Supplied by the ELECTRICAL REVIEW at $4.00.

This book is the outcome of a series of articles prepared by the author for students of machine shop practice at the University of Illinois. The subject is treated clearly and comprehensively, all unnecessary matter being eliminated. No effort has been spared to start the student properly. The simplest tools are taken up and their construction and use explained. Standards of measure and measuring instruments are discussed, and this is followed by a description and instructions for the use of all types of machine tools. The book is intended more for the student than as a handbook for shop practice.

"The Copper Handbook." Horace J. Stevens. Houghton, Mich. Published by the author. Cloth. 600 pages. 6 by 9 inches. Supplied by the ELECTRICAL REVIEW at $5.00 in buckram, and at $7.50 in full library morocco.

This, the third annual issue of this book, has been materially enlarged over the preceding volume. It contains a considerable number of new statistical tables, previous tables having been brought up to date. The chapters devoted to the scientific features of the copper industry have been rewritten and amplified, and a number of new chapters have been added. The greater part of the book is devoted to descriptions of over 2,000 copper mines and copper mining companies in all parts of the world. These descriptions have been made as concise as possible, and the author has spared no effort to make them entirely reliable.

"The Utility of an Academic or Classical Education for Young Men Who Have to Earn Their Own Living and Who Expect to Pursue a Commercial Life." R. T. Crane.

The author of this book has taken this means of expressing his dissatisfaction with the results of college education, a fault from which it would seem he himself is free. The greater part of the book is given up to a criticism of the results of classical education for business men. The defects of technical training are dealt with more briefly. The value of his criticisms may perhaps be judged by the statement "that practically all branches of manufacturing business have been brought to such a wonderful state of perfection that there is very little chance for further improvement in them, even by practical men who possess a large amount of experience, combined with good common sense." Fortunately for the happiness of the world, there are few active men who accept this view.

The Twenty-sixth Convention of the National Electric Light Association.

The Programme, List of Subjects, Transportation and Entertainment.

THE twenty-sixth convention of the National Electric Light Association will be held in Chicago, Ill., May 26, 27 and 28. The headquarters will be at the Auditorium Hotel. The committee in charge are assured a most enthusiastic gathering, and with the greatly augmented membership, this convention bids fair to outdo all those that have gone before.

Mr. James Wolff has been appointed by President Louis A. Ferguson chairman of the local reception and entertainment committee. This committee has arranged to have a general reception in the Auditorium parlors on Monday evening, May 25, from 8.30 to 10.30. Arrangements are also being made for a tally-ho party on Tuesday morning for the ladies attending the convention, to drive to the Washington Club, where they will have luncheon. After luncheon they will drive through the South Park, returning to the hotel in the afternoon. A matinee party at one of the theatres is contemplated for the ladies on Wednesday afternoon.

The following is a list of the gentlemen on the entertainment committee:

Messrs. James Wolff, chairman, J. W. Buell, B. E. Sunny, A. L. Tucker, Homer E. Neisz, W. W. Lowd, W. R. Pinckard.

The following is a list of names of gentlemen on the reception committee:

Messrs. B. E. Sunny, chairman, Samuel Insull, Edward B. Elliott, Frank L. Perry, C. D. Crandall, Truman P. Gaylord, B. J. Arnold, Thomas I. Stacey, H. R. Hixon, F. E. Donohue, R. C. P. Holmes, F. B. Badt, G. H. Atkin, Francis Raymond, J. R. Wiley, A. D. Lundy, C. E. Gregory, George C. Bailey, F. W. Kohler, W. M. Smith, George B. Foster, M. B. Austin, W. S. Goll.

The following plan has been announced for the disposition of business, and reading of papers:

Tuesday Morning, May 26—Address of President Ferguson. Report of Editor of Progress, Mr. T. Commerford Martin. Report on Office Methods and Accounting, Mr. W. M. Anthony.

Tuesday Afternoon—Paper on "Advantages Derived from Use of One System of Generation and Transmission of Electrical Energy from All Power Stations in One Locality," Mr. Charles L. Edgar. Paper on "Standard Ratios for Transformers," Mr. John S. Peck. Paper on "Boiler and Furnace Efficiencies," Mr. A. Bement. Report of Committee on Flue Gases, Mr. Henry L. Doherty, chairman.

Wednesday Morning, May 27—Paper on "The Young Engineer and the Electric Lighting Plant," Mr. Charles F. Scott. Paper on "Tactful Relations with Customers," Mr. John W. Ferguson. Paper on "Attitude of Employers Toward Benevolent, Insurance and Educational Associations Among Employés," Mr. Arthur Williams. Paper on "First Aid Appliances," Dr. J. D. McGowan.

Wednesday Afternoon—Paper by Professor Elihu Thomson. Paper on "Steam Turbines," Professor Wm. Lispenard Robb. Paper on "District Heating," Mr. John W. Glidden. Paper on "The Application of Four-Ampere Series Alternating Arc Lamps for Street Lighting," Mr. J. Henry Hallberg.

LOUIS A. FERGUSON, PRESIDENT NATIONAL ELECTRIC LIGHT ASSOCIATION.

Thursday Morning—Paper on "Salt as a By-Product," Mr. Alex Dow. Paper on "Some Fundamentals of Photometry," Professor H. E. Clifford. Report of Committee on Photometric Values of Arc Lamps, Mr. Henry L. Doherty, chairman. Exhibition and description of the Matthews integrating photometer, Professor Charles P. Matthews. Report on decorative and sign-lighting, Mr. Arthur Williams.

Thursday Afternoon—Paper on "Relative Advantages of Electrical and Mechanical Methods of Variable Speed Control for General Power Service," Mr. William Cooper. Report of "Theft of Current," Mr. Robert L. Elliott. Report "Unaccounted-For Current," Mr. L. G. Van Ness. Report of Committee on Standard Electrical Rules, Captain William Brophy, chairman. Question box. Executive Session—Reports of secretary and treasurer, and executive committee, election of officers.

Arrangements have been made with Mr. M. C. Roach, general eastern passenger agent, New York Central Railroad, for a special train of Pullman cars for the use of eastern members and delegates attending the convention.

The train is scheduled to run by the New York Central & Hudson River Railroad and the Michigan Central Railroad, leaving New York on Sunday, May 24, at 12.50 P. M., Albany at 3.50, Buffalo (central time) at 10.50 P. M., Boston, *via* Boston & Albany, at 10.45 A. M., arriving at Chicago 2.50 P. M. Monday. The fare from New York is $22; return, $6.70.

The officers of the National Electric Light Association are as follows:

Louis A. Ferguson, president, Chicago, Ill.

Charles L. Edgar, first vice-president, Boston.

Ernest H. Davis, second vice-president, Williamsport, Pa.

H. Billings, assistant secretary and treasurer.

C. O. Baker, Jr., master of transportation.

Executive committee, Dudley Farrand, J. H. Perkins, E. L. Bemiss, C. F. Hewitt, Arthur Williams, D. P. Robinson, A. C. Dunham, P. G. Gossler, H. T. Hartman.

Summer Courses at the Massachusetts Institute of Technology.

The Massachusetts Institute of Technology announces courses for the summer term, which will be held during the months of June and July. Courses will be given in analytic geometry and integral calculus, applied mechanics and the mechanic arts, including work in the wood shop and machine shop; mechanical drawing and descriptive geometry; also history, modern languages, and physics and chemistry. Engineering courses are offered in electrical testing, surveying, assaying and architectural design. Professional summer courses will be conducted in several departments, their main object being to make the students acquainted with actual industrial and engineering operations.

The Electric Railroad from Paris to Versailles.

The Technical Equipment and Engineering Features.

By Our Special Correspondent.

THE new electric railroad which has been recently constructed from Paris to Versailles presents many interesting features, both in the electric equipment of the road and the engineering work which was employed in its construction. The new line is designed to take off a part of the overcrowded traffic of the steam railroad leading to Versailles, on which it was found impossible to increase the number of tracks, owing to local conditions, and it was decided to construct a new line which should have a more direct route, besides having its terminal station on the bank of the Seine, and thus nearer the centre of the city than the former station. The new line takes part of the traffic of the main lines of Brittany and Normandy, and also has a large suburban traffic which is principally due to the central location of the new terminus.

A large underground station has been constructed for the main terminus of the road within the city. The station lies on the bank of the Seine at the end of the new Alexander III Bridge, and is underneath the wide avenue which passes from the bridge to the buildings of the Invalides. The lower part lies on a level with the banks of the Seine and is some twenty feet below the street level. This station has been laid out on a large scale and has a great number of tracks, some of which are used for the electric road and the remainder for the tracks of the steam railroad which crosses the Seine a little further down. The tracks are laid in pairs and between each pair is an elevated footway which allows the passenger to enter the cars directly. The roof of the station is formed of I-beams which are supported by cast-iron columns of ornamental design. A part of the footway overhead is formed of embossed glass tiling which serves to light the station. Adjoining the underground part is a station building of handsome design, erected in two stories, into which the passengers enter from the street level and descend to the underground part by staircases. A substation for the lighting circuit is contained on the lower floor. It reduces the main alternating current which is furnished at 5,500 volts to 110 volts direct current; the voltage is first lowered to 220 volts by a set of step-down transformers. Rotary converters of the Alioth type are used to furnish the lighting current. These machines, three in number, have a capacity of 270 amperes and work at 480 revolutions per minute.

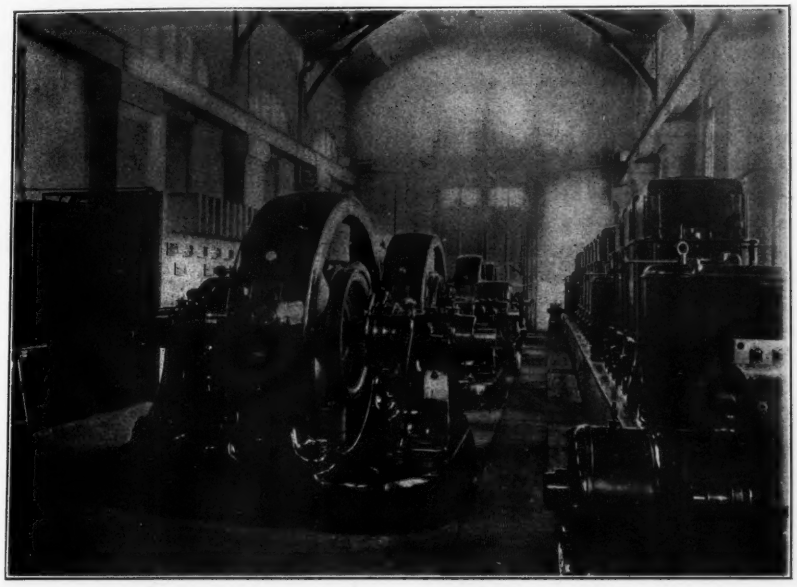
The construction of the road within the city limits has been made easy, as it lies along the bank of the Seine. After leaving the station the road follows along the river in double track, being protected on one side by the embankment wall of the Seine and on the other by a newly erected wall which separates it from the river. The steam railroad uses the same tracks for a certain distance and then branches off to the right. At the Champ-de-Mars a number of side tracks lead to the main yards of the company where are located the extensive erecting and repair shops and a number of tracks for accommodating the locomotives and cars. Here is also located one of the three substations for supplying the line. Outside the city limits the road traverses a flat country, for the most part upon a series of viaducts and embankments, continuing to the long tunnel which has been constructed at Mendon. After passing the tunnel the road continues on a series of slight embankments to Versailles which is the terminus of the line, using the station which has been already erected for the Paris-Versailles steam railroad. The total length of the electric road from the Invalides station to Versailles is 10.5 miles, which is somewhat shorter than the steam railroad.

The long series of viaducts which has been constructed gives the new road a unique and somewhat picturesque aspect. The viaduct construction was decided upon owing to the fact that the ground lies not far from the city limits and is either built upon or is expected to be so in the future, and thus the viaduct would occasion a smaller loss of ground than the embankment, and the latter would have been difficult to construct owing to the slippery nature of the soil. The construction of the viaducts, which represent a total length of 1.4 miles, including 0.45 mile of embankments which separate them, has been unusually difficult owing to the nature of the soil, which is here a plastic clay of a slippery nature. Below the clay lies a bed of chalk which contained a series of superposed galleries for the extraction of the material. These galleries had to be either filled up or lined with masonry. In some cases the foundations of the viaducts go down as low as fifty feet. The quicksands of the Seine region which exist here, consisting of fine sand charged with water, occasioned considerable trouble in placing the foundations. One of the viaducts is shown in the engraving.

THE TRACK AND CONDUCTOR SYSTEM, ENTRANCE TO THE MEUDON TUNNEL, PARIS-VERSAILLES ELECTRIC RAILROAD.

The greatest difficulty in the construction of the road lay in the piercing of the

long tunnel at Meudon, which comes after the series of viaducts. The tunnel measures 2.1 miles in total length. The greater part of the strata composing the hill down to 150 to 200 feet depth consist of sands, and the base of the sand is water-bearing for a thickness of fifty to sixty feet, thus forming a quicksand in which it became very difficult to work. A special method had to be used here, and the masonry of the tunnel was increased in some cases to five feet thickness, to resist the enormous pressure which is exerted upon it. The cost of the Meudon tunnel, exclusive of the track, is estimated at $2,000,000. A view of the tunnel is shown in the photograph. The cost of constructing the first 6.8 miles of the road is figured at $5,200,000, or $760,000 per mile, exclusive of the electric equipment.

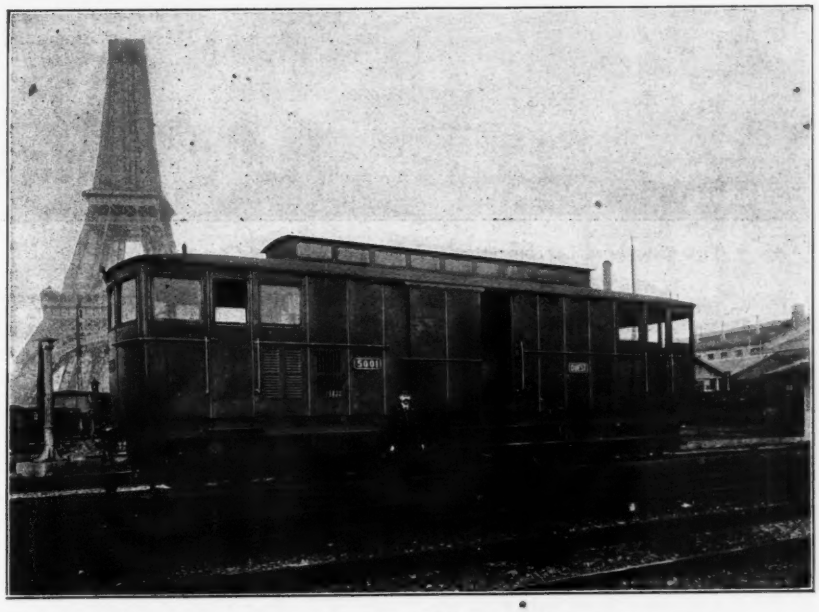


THE SUBSTATION, PARIS-VERSAILLES ELECTRIC RAILROAD.

The railroad company has adopted two different systems of traction, one consisting in the use of a heavy electric locomotive of special construction, which draws a train made up of the standard cars of the Ouest Railroad. The company is also building a number of motor cars which resemble the type of car which is in use on the Paris Metropolitan and the same practice is used in making up the trains, employing two or more motor cars per train. The locomotives proper, which have been built by the Société de Locomotion Electrique, are of the type shown in the engraving. The locomotive is of square build, and is mounted upon two trucks of two axles each. It has a motorman's cab at each end, containing the controllers and apparatus. The remaining space in the middle, which is reached by a double folding door, is used for carrying baggage and has a capacity of six tons or more. The locomotive measures forty-two feet in total length between buffers and twenty-two feet between the centres of the trucks. The latter are of the double-axle type and measure eight feet eight inches between axles, with a wheel diameter of fifty-two inches. The total weight of this type of locomotive is fifty-five tons. Each locomotive is equipped with four motors, having one mounted on each axle; the motors can be connected by the controller in series of two groups in parallel, or all four motors in parallel.

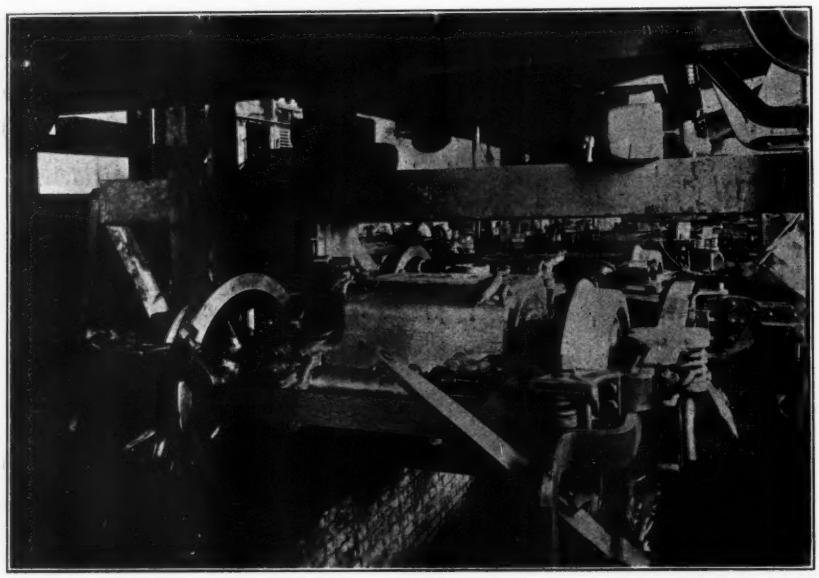
There are ten of these locomotives in use on the road at present; these are all alike as to external appearance, but use three different types of motors. Four of them are equipped with the single-reduction motors of the Postel-Vinay type, with elastic coupling, and the remaining six use gearless motors. Three of the latter use Westinghouse motors and the others the Brown-Boveri type. These two motors are of octagonal shape and are similar in appearance. The locomotives have a normal capacity of 125 horse-power, with a maximum of 200; they were designed to draw a train of 100 tons at a speed of twenty-seven miles an hour on a continuous grade of one per cent, but in fact are capable of drawing a 140-ton train at thirty-two miles an hour. The motors are connected to the driving shaft by elastic coupling. In the case of the gearless motors the armature is mounted on a hollow steel shaft through which passes the axle of the locomotive. The steel shaft carries at each end a triangular plate to the points of which are attached a set of coiled springs which connect the plate to three points on the

THE VIADUCT, PARIS-VERSAILLES ELECTRIC RAILROAD.



THE ELECTRIC LOCOMOTIVE, PARIS-VERSAILLES ELECTRIC RAILROAD.

wheel. For the single-reduction motors the same principle is used, but the armature, instead of being mounted directly upon the hollow shaft, drives it by a pair of gears. In this case the bearings of the hollow shaft are solid with the motor body. This combination of springs secures a good suspension of the motor and gives it an easy running. Two systems of controller are used on the locomotives. Those which use the Postel-Vinay motors have controllers of the same make, using a single main cylinder which makes the connections for the four motors; they are provided with a magnetic blowout. A set of switches is used to throw the different motors in or out of circuit. The remaining six locomotives use controllers of the Westinghouse pattern, of the series-parallel type with two cylinders, which



THE CAR BODY LIFTED, SHOWING DISPOSITION OF MOTOR EQUIPMENT.

are operated at the same time by a single handle, also provided with a magnetic blowout. The starting resistances are contained in four boxes which are mounted in the cabin and are ventilated by shutters opening to the outside. The electric outfit includes an automatic circuit-breaker, lightning arrester and different measuring instruments. The controller is mounted in the centre of the cabin in a box two feet square and three feet high. The locomotives are provided with air-brakes and the air is supplied by a Christensen air-compressor set mounted in the cab and driven by an electric motor. The main air reservoir has a volume of fifty cubic feet. The current is taken from the rail by four rubbing contacts which consist of two pointed pieces pressed by springs against the rail.

Besides the ten locomotives which are now in use, the company is building a number of motor cars of the type shown in the engraving. These are long cars which closely resemble the new passenger cars which are in use on the Ouest Railroad on its branches within the city limits. The space used for the motorman's cab and the controlling apparatus occupies about half the length of the car, and the remainder is fitted out with seats for the passengers. There is also a small cabin in the rear which contains an air-brake handle and part of the apparatus. On this type of car the Sprague and Thomson-Houston systems are used. The car equipped with the Sprague motors and apparatus uses a semi-parallel controller which is placed horizontally in the rear of the cab and is operated by a small motor. The main controller handle, mounted in the front of the cab, operates a series of electromagnets which in turn throw on the various circuits of the motor which operates the controller cylinder. The current is reversed by an independent device which operates an electromagnetic relay. Most of this apparatus is of the American type, and need not be described in detail. The engraving shows the inside of the front cabin on one of the Sprague cars. The cab is reached by a pair of folding doors at either side. The front part, having three windows, is provided with a bench containing the operating handle of the controller, with the air-brake lever on the right and a hand-brake in the centre. In the rear part is mounted an automatic circuit-breaker and the controller cylinders, resistances, etc., while the remaining space is used for the baggage. Another photograph shows the car lifted off the truck and the method of mounting the motors on the axles.

In the car equipped with the Thomson-Houston system the controller is like that

THE INTERIOR OF THE CAB, SPRAGUE CAR, PARIS-VERSAILLES ELECTRIC RAILROAD.

which is used on the street railway cars, but is of smaller size; it sends the current into a set of relays which makes the different combinations of the motor circuits. The train on the Sprague system is made up of nine cars, of which three are motor cars of the above type. When the train is complete the two motor cars occupy the ends of the train, while the third is placed in the middle. The weight of the motor cars is 140 tons empty or 190 tons when fully loaded. The smaller trains use only three cars in all, with the motor cars placed at the ends. The Sprague motor cars are mounted on two trucks, one of which is equipped with two motors, one on each axle. The train made up on the Thomson-Houston system uses eight cars in all, with two motor cars at the ends. In these cars each axle of the two trucks is provided with a motor; their exterior appearance is the same as the former. These cars weigh 125 tons, or when loaded 175 tons.

The current for the motors is collected by rubbing contacts from a third rail which is placed at two feet outside of the track and at eight inches higher level. The rail is of the double-head pattern, weighing 46.8 kilos per metre, and is mounted upon steel supporting pieces with a brace support at each side. It is insulated by blocks of paraffined wood which are mounted on the ties, a certain number of which are increased in length for this purpose. In order to carry out the repairs easily, the rail is sectioned every 1,000 metres and separated at these points by an insulating piece. The section switches are placed in cast-iron boxes and can be worked from the ground by a pedal. The rail is protected at the points near the stations by a wood covering which partly encloses it. The construction of the rail and its accessories

has been carried out by the Société de Locomotion Electrique.

The line is supplied with current from three substations, one of which is located at the Champ-de-Mars depot, the second near the Meudon tunnel, and the third at Viroflay, between the tunnel and the Versailles terminus. These three stations, one of which is illustrated in the engraving, are quite similar in appearance and in the electric equipment for supplying the third-rail circuit. The Champ-de-Mars station also has a set of machines for the lighting circuit. The substations receive the triphase current from the main generating station, which is supplied at 5,500 volts and twenty-five cycles and transform it into direct current at 550 volts for the traction. Each of the stations is equipped with four rotary converters, furnished by the Thomson-Houston Company and built at its Paris shops. Each of the converters is supplied by a set of three step-down transformers, connected one per phase, which lower the main potential to 340 volts before sending it into the rotary converters. The latter deliver 550 volts direct current. To each set, consisting of a rotary converter and its transformers, is added a reactance coil for the automatic compounding of the converters according to the variations of load, and also an induction regulator for the triphase current which allows of raising or lowering the voltage by fifteen per cent of the normal. The rotary converters are disposed along the axis of the building and are six-pole machines compound-wound, working at 500 revolutions per minute; each has a capacity of 300 kilowatts, which may be raised for a short time to 450. On the left-hand side is the switchboard and on the right the transformers and regulators. The transformers are of the air-cooled pattern and are ventilated by a blower operated by a non-synchronous motor (seen in the foreground) and placed at each end of the supporting table. Between the second and third machines is placed a starting group, which is composed of a non-synchronous motor of sixty horse-power, direct-coupled to a direct-current generator. This group furnishes eighty amperes at 550 volts, which is quite sufficient for starting the main converters and bringing them into synchronism with the line. Part of the switchboard will be observed on the left. It has a set of four marble panels for the alternating current, one for each group, followed by a direct-current panel for each of the rotary converters. A separate panel is used for the starting set. The Champ-de-Mars substation also contains a set of rotary transformers which are used exclusively for the lighting circuits of the line and the different stations and shops. These consist of three direct-coupled sets furnished by the Alioth Company, of Lyons. They transform the main current of 5,500 volts into direct current at 110 volts for the lamps. These machines have a capacity of fifty kilowatts each and operate at 480 revolutions per minute.

The high-tension alternating current is supplied to the substations from the large central station which has been erected on the Seine outside the city limits at Moulineaux. This station is one of the largest in France and will be described in detail in a second article. It contains nine direct-coupled alternators of the Westinghouse pattern, of 800-kilowatt capacity, besides four exciter groups. These machines are driven by horizontal engines of the Dujardin and Garnier types, and deliver high-tension current at 5,500 volts.

C. L. DURAND.

Paris, May 2.

Independent Telephone Association of the United States.

The next annual convention of the Independent Telephone Association of the United States will be held in Chicago, Ill., June 24 and 25. Mr. J. B. Ware, of the Interocean Telephone Company, Ellicott square, Buffalo, N. Y., is in charge of the preliminary arrangements, and the remarkable growth and splendid financial condition of the independent interests throughout the country, assure a profitable and enthusiastic convention in Chicago next month.

Opening of the Mersey Railway.

The Mersey Railway has recently been converted from steam to electric, and was thrown open to the public Sunday, May 3.

Preceding the formal opening, an electric train carrying guests was run over the road making a trip over the entire system. For some weeks past the electric trains have been running in between the schedule steam trains, in order to test the system under working conditions and also to train the men. The last steam-propelled train passed over the line at midnight on May 2. A three-minute schedule has been established between Liverpool and Birkenhead.

The road has been converted from steam into electric without any interruption to the service, although the line carries aout ten million (10,000,000) passengers per year and the permanent way had mostly to be relaid. The new system was approved by the Board of Trade on April 3.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

PLANS FOR THE GATHERING AT NIAGARA FALLS, N. Y.

The annual convention of the American Institute of Electric Engineers will be held at Niagara Falls, N. Y., June 29 to July 3.

The general arrangement of the convention is such that the mornings from 9.30 to 1.30 will be devoted to the presentation of papers, while the afternoons and evenings will be devoted to the inspection of places of technical and historical interest. Excursions to various localities in and about Niagara Falls will be arranged for the members of the Institute and their guests. Papers for the convention will be presented in the following order: On Monday morning, President Scott's address, followed by papers and discussion relating to the scope and development of the Institute, with particular reference to local organization. Tuesday morning, the presentation of topics relating to railroading. On Wednesday, long-distance power transmission. On Thursday, miscellaneous topics. And on Friday, a joint meeting with the Society for the Promotion of Engineering Education.

Mr. H. W. Buck, of the Niagara Falls Power Company, has been appointed chairman of the Niagara Falls local committee and will have general charge of all local details, such as the arrangements for entertainment and reception, local transportation and the accommodation of the members.

The attractions in and about Niagara Falls appeal to the scientist and the engineer in many ways.

Excursions of technical and engineering interest will be paid to various manufactories and power plants in Niagara Falls and Buffalo. Some of these are the Niagara Falls Power Company, the Canadian Niagara Power Company, the Carborundum Company, the Niagara Falls Hydraulic and Power Company, the Atmospheric Products Company. In Buffalo the points of interest will be the Great Northern elevator, the Dakota elevator, the Buffalo Dry Dock Company, the Cataract Power and Conduit Company's terminal house, the Buffalo General Electric Company's power station, the Lackawanna Steel Company's mammoth works, the Bell Telephone Company's headquarters.

Transportation arrangements are in the hands of a committee of which Mr. E. H. Mullin, 44 Broad street, New York, is chairman, with Mr. E. B. Katté, of the New York Central Railroad, and Mr. L. S. Boggs, of the International Railway Company, Buffalo, as associates.

The Annual Meeting of the American Institute of Electrical Engineers.

THE annual meeting of the American Institute of Electrical Engineers was held at 12 West Thirty-first street, New York city, Tuesday, May 19. Secretary Pope announced the election of 140 associate members, and that the following associates had been transferred to full membership: Messrs. M. J. Wightman, C. O. Poole, H. T. Hartman and R. S. Kelsch. The report of the board of directors for the fiscal year ending April 30, 1903, was presented. This reviews briefly the work of the year, calling attention to the new lines of activity, particularly in establishing local organizations and granting privileges to students who are pursuing electrical subjects. A summary of the membership shows that on April 30 there were 2,229 total members, this being an increase of forty-four per cent over the previous year. During the fiscal year 865 associates were elected. The financial report shows that the assets of the Institute are $40,599.69. This does not include certain donations made to the Institute, but which have not been turned over to the treasurer, as their application has not been definitely decided upon. The receipts during the year were $30,181.25; of this, $29,559.67 has been expended. The Institute expenses have increased materially over the previous year, due to the new lines of work taken up. A balance of $2,006.75 remains.

The election of officers for the following year was announced as follows: President, Bion Joseph Arnold; vice-presidents, Calvin W. Rice, W. S. Barstow and Ralph D. Mershon; managers, Samuel Sheldon, A. H. Armstrong, W. C. L. Eglin and G. F. Sever.

President Scott reported upon the progress which had been made toward securing a building, reviewing the work of previous years and the hopes of the Institute to unite with other engineering societies in securing an engineering building. He spoke briefly of the offer made by Mr. Andrew Carnegie to give the engineering societies $1,000,000 to erect a suitable building, on the condition that these societies provided a site. He reported the action which had been taken by a conference committee composed of three members from each of the engineering societies, and outlined the resolutions which had been drawn up to be presented by the various bodies interested. These were in effect an acceptance of the gift, with an expression of appreciation for Mr. Carnegie's interest and generosity; an agreement on the site on Thirty-ninth street; appointing a committee of three from each organization, the whole to constitute a conference committee; and giving the committee authority for carrying out the work. The board of directors of the Institute adopted these resolutions and appointed the following as members of the conference committee: President Charles F. Scott; president-elect Bion J. Arnold and Dr. S. S. Wheeler.

He then presented a resolution drawn up by the directors, to be voted upon by the Institute, which endorsed the action of the board of directors. This resolution was adopted unanimously.

Secretary Pope then read letters from noted members of the Institute, expressing their approval of this action. The following subscriptions to the fund for securing the site for the building were announced: Mr. Frank J. Sprague, $2,000; Professor Elihu Thomson, $5,000; J. G. White, $1,000, and offers to raise this to $2,500 if sufficient subscriptions are obtained to secure the property free of mortgage; Westinghouse Electric and Manufacturing Company, $5,000. A message was sent to Mr. Carnegie by cable, assuring him of the acceptance of the Institute and expressing gratitude for his generous gift.

The papers of the evening were then taken up. President Scott introduced the subject in a few words, showing the important part played in dynamo development by the use of electromagnets. He described the various methods of field excitation and of compensating for the effect of load. Some of the problems presented to the designer in this work were very complicated and intricate.

Mr. B. A. Behrend abstracted his paper, entitled "The Experimental Basis for the Theories of the Regulation of Alternators." This paper will be printed in full in a later issue.

Mr. Comfort A. Adams then abstracted a paper, giving results of an experimental study of the Heyland machine as motor and generator. This paper described the Heyland type of machine, explained the reactions which take place within it, gave the theory of its operation, explained the conditions under which this machine had been tested, both as a motor and a generator, and gave results of many tests. His conclusions in regard to the future of this type of machine were summed up as follows: The chief advantages of this type of alternator are non-synchronous, ease of paralleling; automatic compounding for all power-factors; short air-gap, small exciting power; no exciter required; economy of material; and the disadvantages are commutator, this is prohibitive in low-speed machines; more complicated; much greater first cost per pound of material; natural ventilation poor.

The automatic compounding is of little value in a large central station, and the exciting power can not well be reduced below that of good synchronous machines.

The higher price of materials and lower price of labor in Europe may make a success there out of what would be very doubtful here.

The Heyland generator is naturally, for commutator reasons, a high-speed machine with a small number of poles, and may prove useful in connection with steam turbines, although the high commutator velocity may be troublesome.

Mr. G. S. Dunn then abstracted a paper prepared by Mr. A. S. Garfield, which described the Latour method of compounding self-excited alternating-current generators for variation in load and in power-factor. The theory of the machine was given concisely and its action discussed. There are two methods of operation; first, with the speed of rotation of the field structure constant, the machine will operate at constant terminal voltage, but at variable frequency. With a change in construction, it is possible to obtain a machine which will give a constant frequency and which will compound for variations in output and power-factor in one or all of the phases. Commenting upon the objections which might be raised to the presence of a commutator, it was noted that upon all the machines which have been constructed, commutation has been perfect. Pulsations in the magnetic flux are dampened by the field-winding. The dimensions of the commutator may always be made small by a proper choice of the exciting voltage.

Owing to the lateness of the hour, the discussion on these papers was very brief. Mr. Adams confirmed the conclusions drawn by Mr. Behrend. Mr. Waters rather took issue with Mr. Behrend's use of the Kapp diagram, but agreed with him as to the unsatisfactory results which the usual methods of computing armature drop gave. In reply, Mr. Behrend said that the design of electrical machinery was an art and not a science, and, therefore, the designer was forced to have recourse to empirical formulæ.

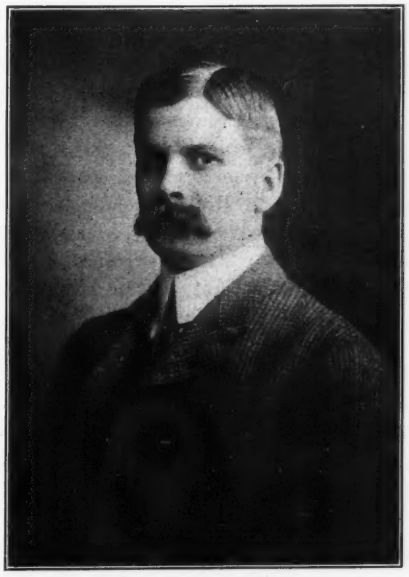
BION JOSEPH ARNOLD.

The career of Bion Joseph Arnold has much in it to encourage the young engineer. Spending his early life under conditions which would have discouraged most young men having ambitions to become engineers, seems in no way to have damped his ardor. Living on the Nebraska prairies when there was not even a mile of railroad in the state, and urged by his father to prepare himself to follow the law, his love for things mechanical was so deep that in spite of all drawbacks he stands now, at the age of forty-two, among the leading engineers of this country.

Mr. Arnold was born in Grand Rapids, Mich., in 1861, and his family moved to Ashland, Neb., in 1864. Here he received his early education at the public schools. During his youth he made many models of machinery, among them being a steam engine and a complete and operative miniature locomotive. Realizing that he was best suited to become an engineer, he entered the University of Nebraska in 1879 and for one year studied engineering there. The following year he entered Hillsdale College, Michigan, taking a scientific course and receiving the degree of bachelor of science in 1884, taking a prize in mathematics. Three years later from the same institution he received the degree of master of science. In 1888 he was following a post-graduate course in electrical engineering at Cornell University. In 1897 he received the degree of electrical engineer from his old college, the University of Nebraska, his thesis being a dissertation upon the design of electrical power stations. This thesis was presented in a course of eleven lectures at the university and it took up in detail the various problems and solutions of power station engineering.

After graduating from Hillsdale College he was made general agent for an engine company for two years, thus gaining a good business experience. He was then engaged as a draftsman for the Edward P. Allis Company, of Milwaukee, but left that company to become general designer of the Iowa Iron Works, Dubuque, Iowa. Later he was engaged with the Chicago, St. Paul & Kansas City Railway Company as a civil engineer and later as mechanical engineer for the same road. He left this position in 1888 to follow the course in electrical engineering at Cornell. After leaving Cornell Mr. Arnold was put in charge of the St. Louis office of the Thomson-Houston Company, which position he held for two years, and then went to Chicago to act as consulting engineer in the same company. Mr. Arnold retained this position after the consolidation of the Thomson-Houston and the Edison General Electric Company into the General Electric Company. Next he established himself as a consulting engineer in Chicago and since this time he has been identified with many important undertakings and large pioneer engineering work. In 1893 he was engineer for the Intramural Railway power plant at the World's Fair in Chicago. This plant attracted much attention as direct-connected units were used.

One objection which had been raised against stations of this type was the inability to operate more than one generator from any one engine; to get over this difficulty the Arnold power system was devised, a system which has been used by its inventor with much success in many instances. By mounting two generators between two engines and by means of four couplings, either engine may be made to drive either or both generators. As the power of these machines was frequently large, it was not thought desirable to use friction clutches, and to meet this end Mr. Arnold designed his magnetic clutch. Clutches of this type have been built and used for transmitting powers up to 3,000 horse-power.



BION JOSEPH ARNOLD.

Mr. Arnold has been a firm believer in the use of storage batteries, and it is largely through his confidence that accumulators hold to-day such an important position in electrical power stations.

A typical example of Mr. Arnold's work is the electrical equipment of the Chicago Board of Trade Building; in this plant Mr. Arnold installed his power system and by means of a storage battery he demonstrated that it was perfectly feasible to drive from one engine all the lights, motors and elevators of a large building.

Mr. Arnold has always been active in the development of electric railways, and a noteworthy example of his work in this line was the equipment of the Chicago & Milwaukee Electric Railway. The conditions there obtaining induced him to propose the use of alternating-current transmission with substations containing rotary converters and storage batteries. His plans for this line gave rise to so much criticism that he took the contract, building and equipping the road along the lines he had laid down, and he had the satisfaction of witnessing the success of his plans, and has since seen the adoption of this system on many other railroads.

Another line of railway work has received a good deal of attention and support from Mr. Arnold; this is the use of alternating-current motors for operating trains. Realizing the difficulties of using directly any of the types of alternating motors which were to be had in the market, Mr. Arnold devised a system by which he believes these difficulties have been overcome. The system consists of a single-phase alternating-current motor, driving the car and an air compressor. The compressed air is stored up and can be used to aid the motor in starting the car, and for moving it over sections of the road where it is impracticable to carry the conducting wires. The system has been entirely worked out and tested upon a railroad built by Mr. Arnold, and it will be soon shown in practical operation.

Another important piece of railway work carried out by Mr. Arnold was the report to the Transportation Committee of the Chicago City Council upon the revision of the street railways in that city. The report was probably the most complete work of this kind that had ever been carried out; it discussed various problems encountered there, conditions at present, and a forecast of the conditions which might be expected within the next fifty years; it gave detailed plans for a revision of the present systems such as would enable them to handle effectively the traffic of that city. When the New York Central Railroad decided to adopt electricity for operating its lines within the city of New York, Mr. Arnold was made one of the commission for preparing the plans. The work to be done here is to operate all the suburban traffic electrically and to move all the through trains

for about thirty-five miles from the terminal on Manhattan Island.

Mr. Arnold is a member of various engineering and technical organizations and has served these on many occasions in an official capacity. He was one of the representatives of the American Institute of Electrical Engineers at the International Congress in Paris in 1900. He is trustee of the Wesfern Society of Engineers and is one of the charter members and first directors of the Technical Club, of Chicago. He is a member of the American Association for the Advancement of Science; of the American Society for the Promotion of Engineering Education; Chicago Automobile Club; Union League Club, of Chicago, and of the Transportation Club, of New York. He has served the American Institute in various capacities and at its recent meeting was elected president for the coming year, Mr. Arnold being the first western engineer to receive this honor. His personal character is such as has drawn to him many warm friends and to excite the admiration and regard of all who come in contact with him. His career has been one which can not fail to interest and inspire the young engineer.

Plans for the Electrification of the New York Central.

Work has been going on steadily in perfecting the plans for the New York Central terminals. The enabling bill has been signed by Governor Odell and this leaves thirty days before submitting the plans to the Board of Estimate. After this has been approved, there will be another thirty days in which to commence work.

The plans contemplate the electrical operation of all the suburban trains by the multiple unit system and the through trains by means of electric locomotives for about thirty-five miles from the terminal. It is expected that arrangements will be made with the Interborough Rapid Transit Company by which the suburban trains will run through the New York subway to the lower end of Manhattan Island.

The through trains will be drawn by electric locomotives as indicated above. The specifications for these are out and are rather general. The locomotive may be operated either by direct or alternating currents, the system being left to the bidding company.

The work at the terminal will commence with lowering the yards along Lexington avenue from Forty-fifth to Forty-sixth street; then the work of installing the electrical system will be taken up. The terminal building will be reconstructed so as to adapt it to the new conditions. The enabling bill allows the company five years to complete improvements, but it is hoped that the system will be in operation before that time.

The Branly Coherer.

In an interview which the writer had not long ago with Dr. Edouard Branly in regard to the new coherer which has been lately described, he states that this coherer, formed simply of a contact between two surfaces, is much more sensitive than the filing tube form, and in fact in some experiments he found it was even five times as sensitive as the ordinary forms; that is, it could be made to work with accuracy at five times the distance. After making a great many experiments with different coherers using metal filings, he arrived by successive degrees at the present simple form. Dr. Branly states that he first brought out the coherer in 1890, when he gave an account of his results to the Academie des Sciences. In these experiments he used a tube filled with metal filings placed between two metal rods, which had at first a high resistance, but upon forming a spark from a Wimshurst or Holtz machine in the vicinity produced a strong deviation of the galvanometer, the resistance being lowered from several million ohms to 2,000, and even 100 ohms; the effect was permanent, but can be restored by a shock. Starting with a few yards distance he made it work as far as twenty yards, through the partitions of the building, in his first experiments. As to how he came to make the discovery of the coherer, he states that the starting point was the observation which he made upon thin metallic layers, and he first attributed their change of resistance to the ultra-violet light of the spark. The first experiments were made with platinized glass plates, and from this a long series of researches led to the filing tube. His new coherer returns somewhat to the elementary form, using an imperfect contact between a bright and an oxidized metal; such a microphonic contact has, however, nothing to do with that of Hughes, who never observed a variation of resistance due to an electric discharge at a distance. As to why he did not invent the system of wireless telegraphy, he states that he was exclusively occupied with the scientific side of the question and wished to find out the cause of the phenomenon, and thus did not take up the question of its practical application, or the construction of the necessary apparatus. For this the credit must be given to Marconi, and Dr. Branly is the first to recognize the fact, claiming, however, to have discovered the germ of the system and without which none of the later inventions could have been made.

C. L. DURAND.

Paris, May 2.

Annual Report of the Wire Department of the City of Boston.

The annual report of the Wire Department of the city of Boston for the year 1902, gives in detail all the work which has been done during the past year, particularly with reference to placing the wires underground, and in moving the conduits to allow for the East Boston tunnel. A large map shows the work which has been planned for the coming year. There is also a summary of fires and miscellaneous troubles, due to electricity, and accidents.

Bettel's process is the electrical precipitation of gold or silver on zinc shavings, using a coated lead anode, the current being of such volume that a tension is produced higher than the back electromotive force between zinc and oxygen in a cyanide solution of whatever strength may be used. The zinc does not appreciably dissolve; and the gold, once precipitated, never redissolves. In the boxes, solution can be put through continuously, if required, for three months without attention, provided a constant current be maintained and the solutions entering the boxes are filtered. If zinc be present in the solution it is precipitated as a flocculent sponge carrying some gold; a filter interposed between the boxes and the sump is therefore occasionally required. The zinc, when taken from the boxes, has a jet black appearance, and is in condition to transfer to extractor boxes of the sands plant, using ordinary zinc precipitation. The Betty or zinc-lead process consists of the ordinary zinc process, the zinc being lead-covered by dipping in strong acetate of lead solution and a strong solution allowed to flow into the head of the box to promote electrical activity of the zinc-lead couple. The zinc-lead couple retains its activity for a time, varying with the impurities contained in the solution. In solutions saturated with zinc ferrocyanide the process may only be effective for forty-eight hours unless a heavy dose of cyanide is introduced. At other times it may go nearly a month without the effluent being higher than nine grains of fine gold per ton. The oxidized zinc with adhering oxides and ferrocyanides is transferred to the ordinary zinc extractor boxes, where the coating is removed by and dissolved in the strong cyanide solution at the expense of the precipitation for the time being.—*Mining and Scientific Press,* San Francisco, Cal.

THE DESIGNING OF TELEPHONE APPARATUS—XXII.

BY W. A. TAYLOR.

Central Energy Systems—A central energy system, in its strict sense, is one in which all energy for signaling, as well as for talking, is supplied from a central point. Such systems are also called common battery exchanges. The number of possible combinations of circuits in such systems is most numerous, and it is a poor telephone engineer who can not produce one or more such circuits, differing in some respects from any other in existence.

There have been many arguments relative to the merits of central energy as compared with local battery systems, but where properly designed, the central energy system will compare favorably with any local battery exchange. It is, of course, true that for toll lines and other systems where the lines are quite long the common battery idea fails, but it is not intended that it shall work on such lines. It is only in local exchanges where the common battery system is superior.

The idea of common battery distribution is not entirely new. In truth, telephone engineers have been striving for such a scheme almost since the first telephone exchange was built. The idea of a large number of telephones being connected in multiple with one battery would solve a great deal of the expense attendant to a local battery system. The telephones would be much simpler, as there would be no generator and the expense of inspection could also be largely reduced. How to attain this result was not really solved until the storage battery became a commercial success. Previous to that time it was possible to create a central energy system, but with primary batteries the expense became enormous. In addition to the expense, there was a great amount of cross-talk due to the internal resistance of the batteries. Probably the first commercial central energy system was used to operate the transmitters of the operators in an exchange. One large cell of storage battery was used, to which all the operators' transmitters in the exchange were connected as shown in Fig. 59. E represents the battery, A, B and C the transmitters connected to the heavy bus-bars D and F. It is very necessary that these bus-bars shall be heavy, as well as their connection to the battery. The cell of battery is of large capacity and of very low internal resistance. The large capacity is to assure low internal resistance. If any appreciable resistance is introduced into the battery and the bus wire connections the operators can hear each other. The idea in this case is, of course, to prevent the talking of one transmitter to the other, and the matter of transmission does not enter. If there were a series of cells so as to receive sufficient voltage

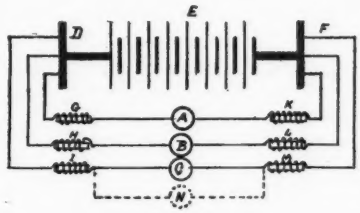


FIG. 59.

to overcome the resistance of impedance coils placed in the transmitter leads at G, K; H, L, and I, M, some resistance could be introduced in the battery circuit. In such a case the impedance has a tendency to prevent any fluctuation in the

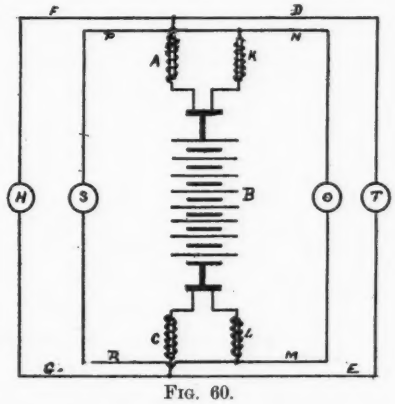


FIG. 60.

current passing through the other circuits. It is not safe to have much resistance, even in this case.

The fact that an internal resistance in

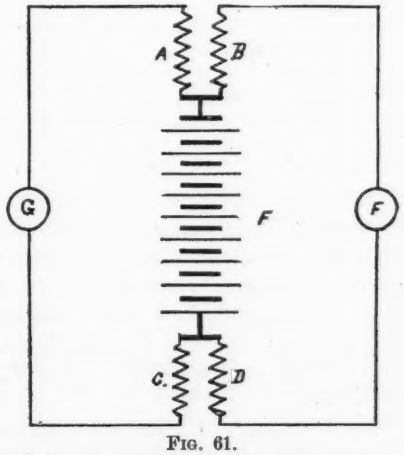


FIG. 61.

the battery circuit produces cross-talk between the transmitters might lead one to the proper method of transmission from one telephone to another. Evidently the scheme shown in Fig. 59 will not do, for when one party talked everybody else would hear what he was saying. Suppose another transmitter is inserted on the same lead as C, with the impedance coils I and M between the two poles of the battery and the two transmitters. Evidently C and N can talk to each other, for their battery circuit has a high resistance. They will not be heard by parties at the transmitters, A and B, because whatever of the talking current which passes through the impedance coils I and M will be short-circuited by the battery away from the circuits of A and B.

We now have a method by which we can transmit conversation without being heard by any other party except the one connected. The diagram is shown in Fig. 60. In this diagram are shown two circuits, one connecting telephones H and T and the other telephones *s* and *o*. The first circuit has the impedance coils A and C placed between the two sides of the line and the battery; the second circuit has the impedance coils K and L likewise placed. These coils afford a passage for the current to get to the line, and owing to their retarding effect they prevent the short-circuiting of the undulating talking current through the battery. Some current will, of course, pass through the coil, but it will largely short-circuit through the battery. Whatever talking current would tend to go out on the other lines will be choked back by the coils on those lines.

But how will the change in the current at H affect the telephone T and vice versa? This may be explained by a numerical case, which will show that whenever there is a change in the resistance of line FGH there will be a corresponding change in line DET. Suppose the resistance of line FGH and DET is each one hundred ohms. The resistance of the impedance coils A and C is fifty ohms each. The battery has a voltage of twenty. The total resistance in the battery circuit, counting the battery resistance as zero, would be 150 ohms. A current of 0.133 ampere would flow, half of which (0.066 ampere) would flow through each telephone. Suppose through the action of transmitter H the resistance of that circuit is raised to 200 ohms, there would then be a total resistance of 166.66 ohms interposed in the battery circuit and a total current of 0.12 ampere would flow, one-third (0.04 ampere) of which passes through H, and two-thirds (0.08 ampere) passes through T. We then see that the current through

T has increased from 0.066 ampere to 0.08 ampere. In this manner we see that any change in one end of a circuit, due to fluctuations in resistance of the transmitter, causes corresponding changes in the current at the other end. The larger the change at one end the greater the change at the other end. In order that the connections may be made with any telephone, the impedance coils are connected in the cord circuit, making it possible to plug into any line without difficulty. This system is what is commonly called the Stone system. It has one very grave defect, and that is because of the unequal distribution of current between lines of different length, the short line will rob the longer line of current. In order to obviate this difficulty some means had to be devised to give each line a separate source of current; that is, make the two lines independent of each other so far as the current supply was concerned, but continuous so far as the conductivity of the talking current was concerned. The first scheme to get around this difficulty was by means of a repeating coil in the cord circuit. A diagram of such a circuit is shown in Fig. 61. The repeating coil has the middle of each half opened and then connected to a battery, that will then really make four coils, A, B, C and D. In this circuit the method of transmission is seen to vary considerably from that of the Stone system. A change in the resistance of the transmitter G causes a change in the amount of current flowing through the coils A and C of the repeating coil; this change in resistance and consequent change of current cause a change in the magnetic field of the coil, and this latter change of magnetism induces a current into the secondary of the coil B and D; this induced current then affects the receiver of the instrument F. With this system the central energy system became a success, and there are many exchanges using this identical idea. This circuit is what is called the Hayes system. With this idea as a basis the Bell companies are using an improvement commonly called the Scribner circuit. From these beginnings the modern complex circuits have been evolved with all their lamp signals and supervisory lamps. In the Bell systems the battery for talking is all supplied through the windings of the induction or repeating coils. In other systems the current is supplied through the various relays of the circuit, some of which are in the cord circuit and some in the line circuit.

New Engineering Building for the University of Pennsylvania.

Plans have just been completed for a new Engineering Building to be located at the corner of Thirty-third and Locust streets, facing Dental Hall on Locust street, Philadelphia, Pa.

The building is to be 300 feet long and 160 feet deep, with a wing fifty feet wide on the west end extending forty feet further to Chancellor street in the rear. It is to be three stories high with a basement covering about one-third of the area. By a suitable scheme of terracing, full advantage will be taken of the natural downward slope of the ground toward the east to convert the basement at that end into practically a first story. The total floor space available in the building will be approximately 128,000 square feet, distributed as follows:

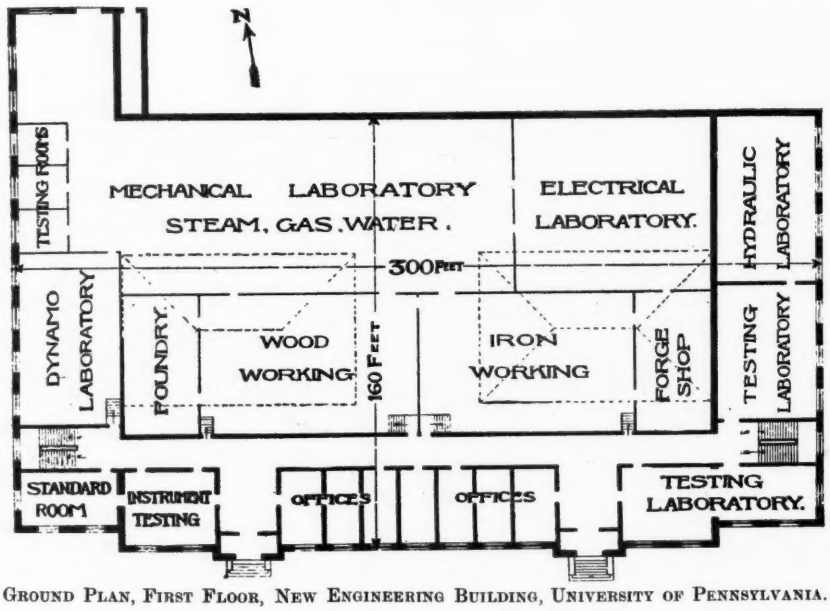
	Square Feet.
Basement	15,600
First Floor	47,000
Second Floor	32,600
Third Floor	32,600
Total	127,800

The construction will be fireproof throughout. The exterior will be of dark brick with sandstone trimmings, and the general architectural treatment and finish of the building will be in strict keeping with the high standards observed in the more recently constructed university buildings.

There will be two principal entrances leading to the main hallway which will extend over the entire length of the building to staircases at both extremities. Two light-wells, about eighty by fifty feet, terminating in skylights over the first floor, will ensure an abundance of light throughout the interior of the building.

The basement along the front will be occupied largely by commodious locker-rooms and lavatories and by the necessary engine and machinery equipment for heating and ventilating purposes. A storage-battery room, to be used in connection with the electrical laboratories, will be located at the west end.

Along the eastern side of the building the basement will lie entirely above the ground level, becoming here virtually a first story, as previously stated. The space on this side will be assigned mainly to various laboratories. The surveying instruments will be kept in a room within easy access of a side exit, and this room will be utilized also as a geodetic laboratory. The hydraulic and physical testing laboratories will be located partly in this end of the basement. The remaining space will be occupied by a small laboratory for testing brick and by a shop and storage room.



GROUND PLAN, FIRST FLOOR, NEW ENGINEERING BUILDING, UNIVERSITY OF PENNSYLVANIA.

FIRST FLOOR.

On the first floor, immediately adjacent to the main entrances, will be the offices of the heads of the departments.

A spacious laboratory for the testing of cements, mortars and concrete will occupy the southeast corner. The eastern side of this floor will be otherwise occupied by the main physical testing and hydraulic laboratories, both extending partly into the basement, as previously stated. On the west end, opening out of the main hall, will be an instrument-testing room for the calibration of indicators,

thermometers, calorimetric work with fuels, etc., and beyond that an electrical standard room for the comparison and correction of electrical testing apparatus of every variety. The remaining mechanical and electrical laboratories will be situated on a floor four feet below the entrance hall.

The central space under the skylights, about 200 by 50 feet, will be utilized entirely for workshops. In the western end will be a foundry equipped with a small cupola, brass furnaces and light crane for handling flasks and ladles. A moderate-sized sand-floor in the centre, and a small core oven and benches around the outside, will complete the equipment.

The woodworking and pattern shop will extend to the middle of the building and will be divided into two parts, the one intended for beginners and the other for students engaged on pattern work.

The tool room supplying the wood and iron shops will be placed directly at the centre of the building. To the east of this will be an iron-working shop divided into two departments, one for beginners, the other for more advanced students.

The eastern end of the shop space will be devoted to the forge shop. To the west and north of the shops will be the mechanical laboratory and part of the electrical laboratories. At the western entrance will be a dynamo and motor room in which direct-current work will be carried on. Provision for high-voltage and railway work will be made in the adjacent laboratory.

Adjacent to the mechanical laboratory will be the electrical laboratory, in which all measurements to be made away from the machines will be carried on.

SECOND FLOOR.

A reference library and reading-room will occupy the central space on the front of the building. The library and stack at one end have been planned to hold about 20,000 volumes. The library is flanked on either side by a series of recitation and lecture rooms, which are continued along both ends of this floor.

Between the light-wells at the centre of the building will be a students' assembly room with about 2,500 square feet of floor space. Instructors' rooms will be provided along the south side of the light-wells.

The rear portion of this floor for nearly the entire length of the building will be assigned to drawing rooms. A separate room will be allotted to each class and an individual desk to each student, so that he may have free access to same at all hours.

The extension on the west side will be utilized for an alternating-current laboratory, with facilities for two and three-phase work and photometric work. An instrument repair shop will be adjacent to this laboratory.

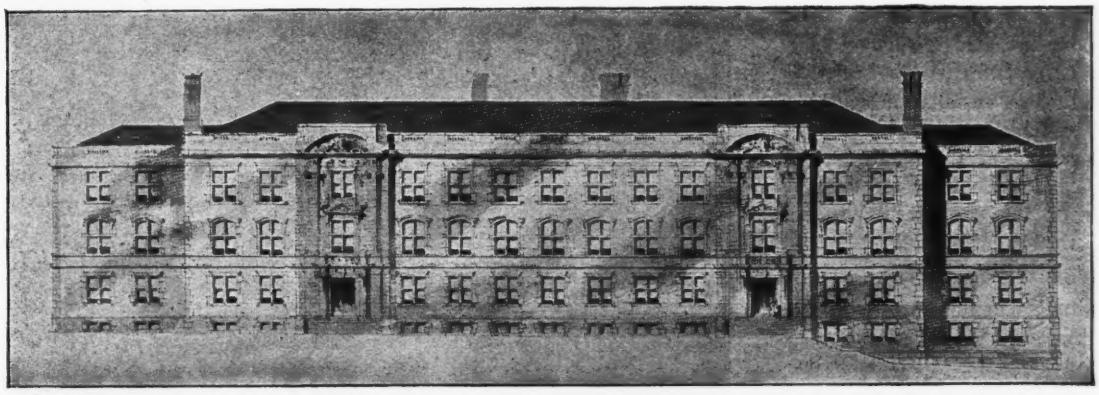
THIRD FLOOR.

A room intended for the use of the engineering societies, a general supply store and the library stack will occupy the middle of the front of the building; the space along the front being otherwise assigned to classrooms and to instructors' rooms along the south of the light-wells.

In the east and west wings spacious rooms will be set aside for engineering museums. The rear of this floor will be devoted entirely to drawing rooms which, like the drawing rooms on the second floor, will have the full advantage of north light through windows of ample dimensions.

The building will be heated by direct steam, the ventilation being provided for by electrically driven fans, supplying tempered air to the various rooms. The lighting throughout will be by electricity.

It is expected that the building will be completed and made ready for occupancy by the fall of 1904. It may be confidentially affirmed that the university will then be in possession of unexcelled facilities for purposes of engineering instruction.



THE NEW ENGINEERING BUILDING, UNIVERSITY OF PENNSYLVANIA.

Military Electrical Manoeuvres.

That there are many directions in which electricity is capable of serving in connection with modern warfare was demonstrated at the Military Tournament recently held in Madison Square Garden, New York. Company M of the Thirteenth Regiment Heavy Artillery N. G. N. Y., composed principally of electrical workers, under the direction of Sergeant M. C. Sullivan, gave an illustration of the quickness and effectiveness of electricity in harbor defence, and showed a thorough knowledge in handling and installing electrical military and naval appliances.

The large arena of the garden representing a harbor was taken possession of by the electricians of Company M, who in a short space of time, on a small scale, installed a complete equipment of submarine torpedos, and the necessary signaling device to establish communications with all points of the supposed harbor. The signaling apparatus consisted of searchlights, telephones and incandescent lamps. The lights in the garden were extinguished and the garden in darkness represented night or the time when that vigilant and willing agency electricity must supplant the eye of the sentinel soldier. A powerful searchlight, located in the distance, scanned the surface of the miniature harbor and soon detected a hostile vessel trying to steal in under cover of darkness. The discovery and the location of the vessel and other information were instantly communicated to the men stationed in the pits and elsewhere, and arrangements were made to destroy the invader. The progress of the ship was noted by other searchlights and a second, third and fourth vessel were discovered.

The first vessel had proceeded but a short distance when, at a signal from the control point, a torpedo was discharged by closing the circuit through the switchboard located in a pit underneath, which destroyed the vessel completely and set the fragments on fire. The second vessel was no more successful and an effort on the part of the third and fourth vessels to retreat brought them a similar fate amid applause from the enthusiastic spectators.

Company M believes in the old adage "In time of peace prepare for war," and the thoroughness and despatch shown in their exhibition are greatly to their credit, but more particularly is credit due to Sergeant M. C. Sullivan who designed the system and so successfully instructed and drilled the men in its operation.

The Distribution of Electrical Energy at 20,000 Volts in the Department of the Aude.

A System with 400 Kilometres (250 Miles) of Lines.

By Enrico Bignami.

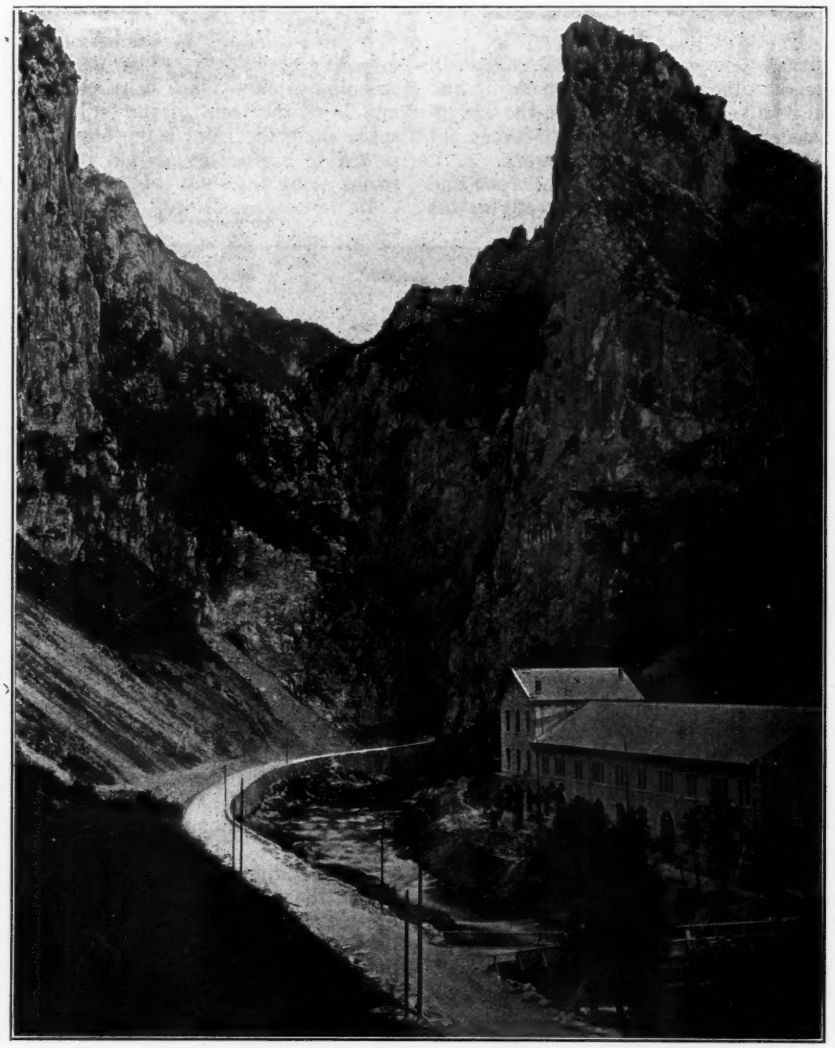
ONE of the recent and interesting hydroelectric installations for high tensions is without doubt that modern achievement in the Department of the Aude, France. This system was installed by the Société d'Applications Industrielles, of Paris, and is noteworthy for the hydraulic, as well as for the electric equipment, and particularly in respect to the distance of the generating station from the centres of utilization; these distances varying from seventy kilometres (forty-four miles) to 130 kilometres (eighty-one miles). It is also noteworthy on account of the extent of the distributing system, covering to-day 400 kilometres (250 miles) of lines, which will be increased ere long to 600 kilometres (370 miles). The carrying out of the whole installation shows a notable progress in the electrical industry, and the operation of the plant for one year affords an opportunity for drawing conclusions of the greatest importance from a practical point of view.

GENERATING STATION.

This is situated in the Corbiere Mountains, at the entrance of St. Georges Gorge, two kilometres (one and one-quarter miles) from Axat, and makes use of a fall of the Aude, having a height of a little over 100 metres (328 feet). One long feeder runs from this station, and terminates, after a distance of seventy kilometres (forty-four miles), at the centre of distribution, situated at Fabrazan, the small county seat of the Canton Department. From this centre of distribution separate three principal branches; the first running to Norbonne, a distance of thirty kilometres (eighteen and one-half miles); the second to Carcassonne, a distance of thirty-five kilometres (twenty-two miles), and the third to Nouvelle, a distance of thirty kilometres (eighteen and one-half miles). These principal branches furnish energy directly to all points situated along their lines, but they serve principally to feed the secondary centres of distribution in which the high tension is reduced to a mean tension, and from these secondary centres of distribution spread the principal distributing lines.

THE DAM FOR CONTROLLING WATER.

This is placed about sixty kilometres (thirty-seven miles) below the source of the river, in a place where the valley widens, giving a basin sufficiently large for settling. This settling is necessary, as the river carries in suspension mud and sand. The dam is of masonry, and has a crown of cut granite. It forms a weir forty metres (130 feet) long, and has two discharge sluices and one fish ladder.



THE POWER STATION AT ST. GEORGES, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

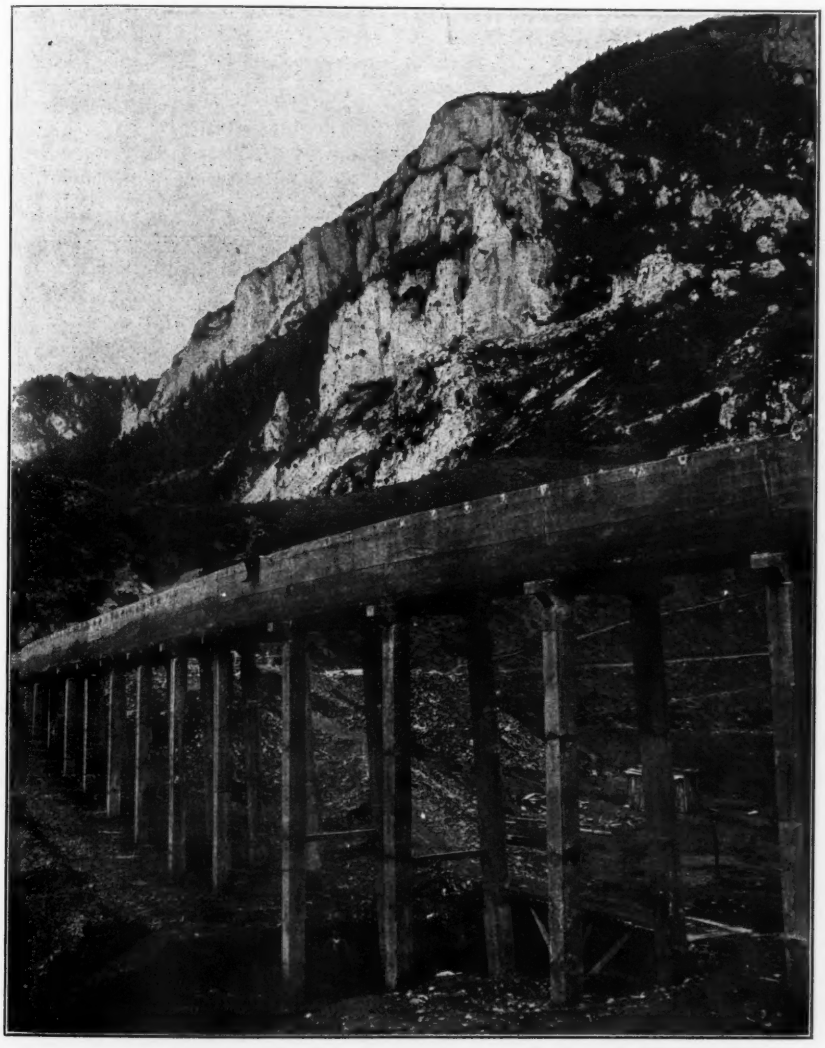
THE CANAL.

The canal has a capacity for delivering six cubic metres, and is seven kilometres (4.3 miles) long, of which three-quarters is tunnel and one-fourth in the open air. The underground canal has been pierced under the flank of the mountain, and was worked from many points, this being necessary to secure rapid execution of the work. During the driving of this tunnel two sorts of schistaceous earth were discovered. In the first, light concrete with smooth cement above sufficed to form the canal, as the limestone was very solid. This was not sufficient in the slaty schist, which is very solid when uncovered, but becomes friable, due to the contact of the air. For this part of the tunnel it was necessary to build a vault resting on piers. The open canal, on the contrary, has been constructed of reenforced concrete, mounted on posts of the same material. The use of reenforced concrete made the work very easy to carry out in that part of the valley when the ground

did not appear sufficiently solid, and also facilitated the crossing of a small valley on a concrete trestle. The tunnel is an approximately rectangular section, two metres (6.5 feet) square, with a slope of 1.6 millimetres per metre (0.02 inch per foot). The slope of the open canal is a little greater, thus permitting a reduction of the cross-section.

THE PIPE LINE.

About 200 metres (650 feet) from the station is a basin, and immediately after this is placed the beginning of the pipe. A grill and valves are provided for each



Concrete Flume Crossing a Valley, Aude High-Tension Transmission System.

of the two pipes. Four of these pipes are planned for, two being actually in place. Each of these pipes is of steel plate, one metre in diameter, and riveted in sections three metres (nine and three-quarter feet) long. Each pipe can pass 1,600 litres of water per second, at a velocity of two metres (6.5 feet). The pipe is about 160 metres (525 feet) long, and each is divided into two twelve metres above the power-house, these being seventy centimetres (2.3 feet) in diameter, and each feeding one turbine. Just at the bifurcation, the flume is free to again slip on the masonry pillars which support it. To allow for expansion at this point, it is held by iron chains anchored in a block of masonry of forty cubic metres. To avoid the water hammer which is produced when air is mixed with the water, a relief valve formed of a tube pierced with holes which allow the escape of the air, has been placed at the upper part of each flume. The loss of head is 1.1 metres (3.6 feet) in each pipe, when the output reaches 160 litres and is feeding two of the turbines in the station.

THE POWER STATION BUILDING.

This building is rectangular in form, and is flanked at its two extremities by two wings. The central part of the station contains the turbines and alternators. The wings contain the step-up transformers, the high-tension switchboard, the repair shop, and some dwelling rooms. Eight groups of turbines and alternators, each of 800 horse-power, are planned for. At present, four groups are in place and in operation.

TURBINES.

The turbines, which were constructed by the Societe des Ateliers de Construction, of Vevey, Switzerland, have a horizontal axle and revolve at 300 turns per minute. They are designed for a normal output of 800 horse-power, and are of the Pelton type, provided with four nozzles. A cylindrical valve, sliding over the nozzle on a ball bearing, and controlled by an automatic speed governor, or by hand, allows more or less water to flow. The axle of the turbines is 3.5 metres (11.5 feet) above the level of the water in the tailrace, as these turbines can not operate submerged. Nevertheless, that height of fall is not entirely lost, because of a special arrangement which, while allowing the entrance of air and preventing flooding the turbine, maintains in the discharge pipe a column of water mixed with air, producing a partial vacuum, and allows the recovery of part of the 3.5 metres fall which, without this arrangement, it would have been impossible to utilize. Each turbine is supplied with an automatic speed regulator, which operates most satisfactorily. This governor has an hydraulic operating motor, utilizing for that the water under pressure of the fall, preferably cleaned by passage through a filter.

THE ALTERNATORS.

The turbines are connected directly to the alternators by means of flexible couplings which form the flywheels. These machines were constructed on the Alioth system, of Bale, Switzerland, and are capable of delivering 700 kilowatts, with a power-factor equal to unity, or about 540 kilowatts with a power factor of 0.8 when absorbing 800 horse-power. Their voltage is 2,900. These are inductor machines, delivering three-phase current at fifty cycles, with the armature connected in star. The exciter is attached to the end of the shaft. The exciting current, at a voltage of from fifty to sixty, is about twenty-five amperes at full load, making a consumption for excitation which is not more than one-quarter per cent. The efficiency of these machines at full load is ninety-three per cent, and their drop of potential five per cent with a power-factor of unity, and sixteen per cent with a power-factor of 0.8. They weigh thirty-five tons, twelve tons of which are for the revolving part. The current from each

alternator passes immediately from the terminals through fuses of German silver placed near the machines, but separated sufficiently from each other.

THE LOW-TENSION SWITCHBOARD.

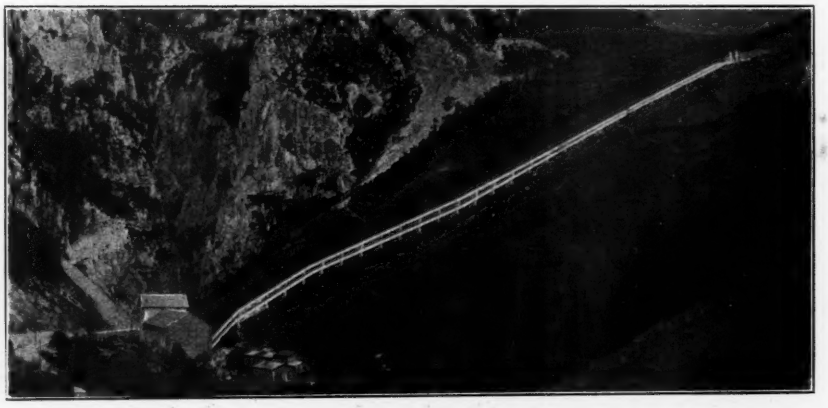
The alternator switchboard includes a generator panel with all the usual appliances. The machines are operated in parallel on bus-bars, and they run in this way without any difficulty, each turbine being supplied with an automatic speed regulator. The alternator field rheostats can be coupled together, allowing the hand-wheel to regulate the voltage of all the machines in service. The current which is to be raised to 20,000 volts by the step-up transformers is drawn from these bus-bars.

STEP-UP TRANSFORMERS.

These are single-phase transformers, after the Alioth system, each having an output of 200 kilowatts. They are grouped by threes in star, forming a three-phase grouping of 600-kilowatts capacity, corresponding to the capacity of the alternators. There are in all twelve 200-kilowatt transformers, air-cooled, placed in a special room, the ventilation of which is provided by two large chimneys situated in the corners. The air, passing in through the transformer room, is drawn from the dynamo room, where it is relatively cold and dry. All these transformers work in parallel, in groups of three, and the high-tension current is conducted to a high-tension switchboard placed in a special room above that of the transformers. Each group of transformers has in the dynamo room its own low-voltage switchboard. Each includes a three-pole switch and ammeter, and the operating handle for the three-pole high-tension circuit-breakers. The latter is operated from a distance by means of air under pressure of five kilogrammes (eleven pounds), the high-tension circuit-breakers being placed in the high-tension switchboard room. For this purpose an air compressor, operated by a three-phase motor, and fed by one of the station lighting transformers, has been installed. A compressed air reservoir and a pipe line connecting this reservoir to the two high-tension and low-tension transformer switchboards complete the entire installation.

THE HIGH-TENSION SWITCHBOARD.

This switchboard includes the high-tension circuit-breakers operated by compressed air, the fuses, and the omnibus bars for 20,000 volts. All the framework of the switchboard is of iron, and the connecting wires are carried on insulators similar to those on the line. Finally, a group of four circuit-breakers, with measuring transformers, the secondary of which is connected to a voltmeter, serve to indicate at all times the voltage between the wires, and between the wires and the earth. This apparatus renders an important service, for it allows faults which may occur on the line to be tested for during operation. These are noted in the ordinary manner. An insulated floor, carried on insulators, allows the switchboard to be approached without danger. The passage of the high-tension cables through the wall is made by oblique openings arranged at the exit of the station. They pass directly toward the line, and are furnished with three Siemens horn lightning arresters supplied with rheostats. The high-tension switchboard is, in addition, protected by choking coils.



POWER-HOUSE AND PIPE LINE, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

DISTRIBUTING NETWORK.

The power station at St. Georges will be able eventually to furnish 3,200 kilowatts, but the first installation contemplates only the production and distribution of one-half of that power—1,600 kilowatts. Under these conditions it was thought advisable that the potential should not surpass 20,000 volts. This voltage was adopted because it guaranteed better operation of the lines, and made easy good construction of the relatively small transformers, such as were needed. The distributing network furnishes electric current to about 100 communities of various importance, representing a population of 150,000 persons.

THE FEEDER.

This has been calculated so that the maximum loss of energy when transmitting seventy kilometres (forty-four miles), will be twenty per cent when the power developed at the generating station is 1,620 kilowatts, with a power-factor of 0.8. Although this loss of energy is great, seventy-five tons of copper have been used in the feeder. A smaller loss would have necessitated a considerable increase in the cost of the first installation, and, on the other hand, there is abundant power. Moreover, it will always be easy to decrease the line loss when the income warrants it, by doubling the weight of copper; or, what will be better, by constructing a second line parallel to the first. The feeder consists of three cables, each thirty-eight millimetres (150 mils) in diameter, arranged in an equilateral triangle, and spaced sixty centimetres (twenty-three and six-tenth inches). The sag is sixty centimetres. The poles are ten metres (thirty-three feet) high, and are spaced forty metres apart (132 feet). They are not sulphated, but have been coated with boiling pitch. The large triple-petticoat insulators were tested, before erection, at 40,000 volts, but in spite of that a number of them have been pierced by the current after some time. It is easy to recognize the doubtful insulators, because they become luminous at night.

MAINTENANCE OF THE LINE.

For inspecting the feeder, which crosses a very mountainous country, every ten kilometres (six and two-tenth miles) of the line have been assigned to an inspector whose business it is to make a trip over his section every day. He reports the condition of the insulators and poles and wires by means of a post telephone on the telephone line which connects the generating station with the centre of distribution. The current is cut off from the lines every Sunday from two o'clock in the morning to three o'clock in the afternoon, and during this time all urgent repairs are made. Accidental short-circuits have been caused by branches of trees, by the wind, and also by birds of prey. A

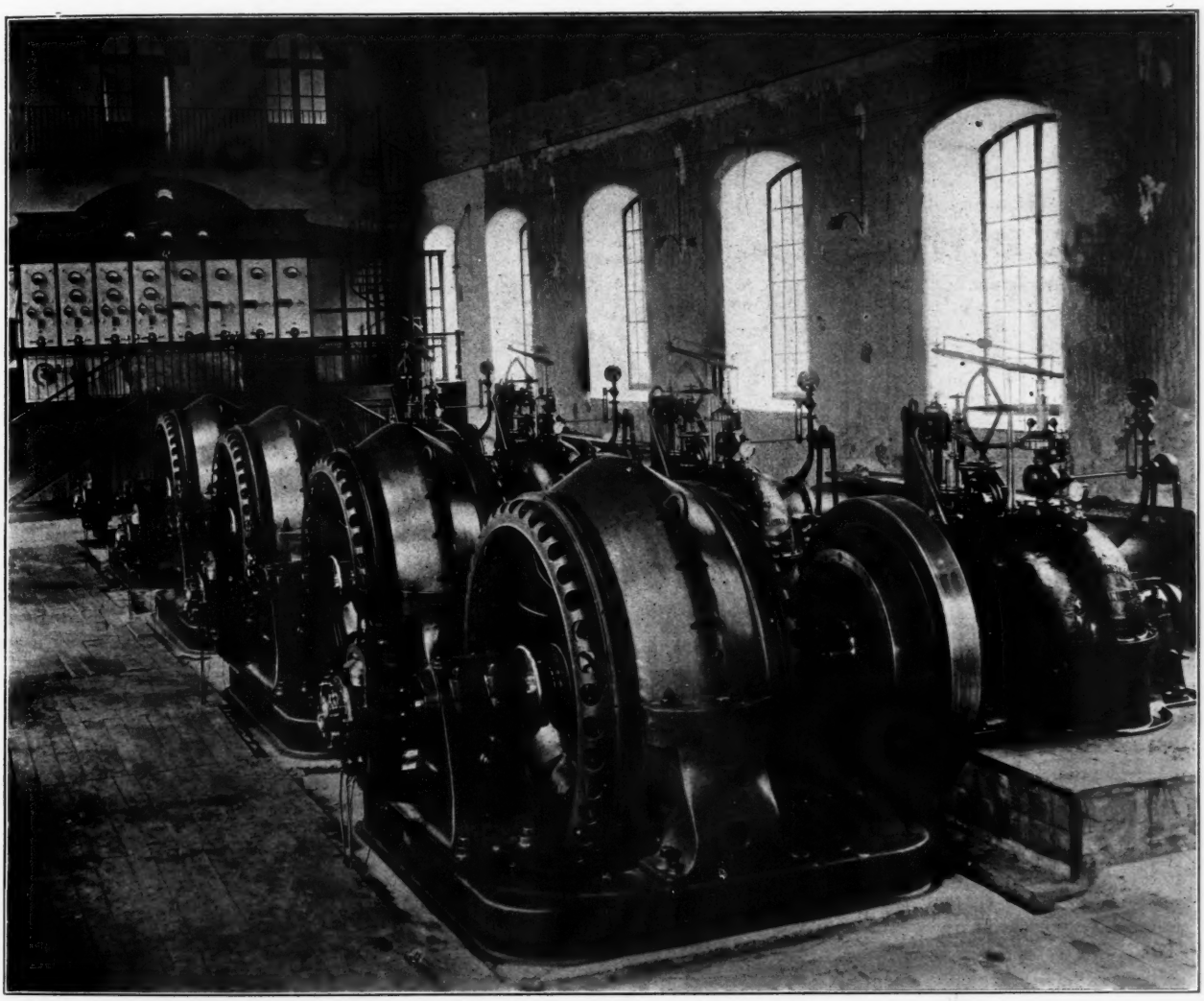
number of the latter have been killed by the current and found below the wire, one of them measuring two metres and sixty centimetres (eight and one-half feet) from tip to tip. Whenever a short-circuit occurs there is an instantaneous rise in the voltage, which in one case reached 35,000 volts. At this point a discharge takes place at the lightning arresters.

THE CENTRAL DISTRIBUTING STATION.

The central distributing station is situated at Fabrazan, seventy kilometres (forty-four miles) from the generating station, and from this point separate the various branches. This station contains the large receiving and distributing switchboards, equipped with switches, circuit-breakers, ammeters and voltmeters. These switchboards are constructed entirely of iron, all connections being made of bare wire mounted on insulators identical with those of the line. The measuring apparatus is also mounted on insulators. Siemens horn lightning arresters are placed on the exterior of the building, and the grounding connection includes resistance. The voltage is indicated at all times in this station by a voltmeter connected to the secondary terminals of a transformer, carefully insulated, but placed in the open air.

HIGH-TENSION BRANCHES.

The branches leaving this central station are three in number. One goes to Narbonne, a distance of thirty kilometres (eighteen miles); the second to Carcassonne, thirty-five kilometres (twenty-two miles), and the third, known as the "Coast Line," to Nouvelle. These branches are all fed at 17,000 volts, and the loss allowed in the line is five per cent. Villages situated along these branches are fed directly by means of transformers, lowering the pressure from 17,000 to 130 volts; but for those which are not on the immediate line, in order to prevent indefinite increase in the high-tension network, the voltage is first lowered from 17,000 to 5,500, feeding into secondary lines. The secondary stations for distributing at this potential contain transformers generally with an output of 100 kilowatts, placed in the special houses which, in general, contain in addition a transformer for lowering the voltage from 5,500 to 125 for the vicinity of this station. Among the interesting details of this high-tension line will be noticed the crossings at the railroads. The 20,000-volt transmission lines cross the track of the Compagnie du Midi at four points, and the railway company required the crossing to be made under trestles by means of insulated cables. This has been done with paper-insulators and lead-covered cables, connected to the overhead lines by means of special wooden junction boxes. These cables are attached directly to the masonry of the trestle, so that the lead sheathing is grounded.

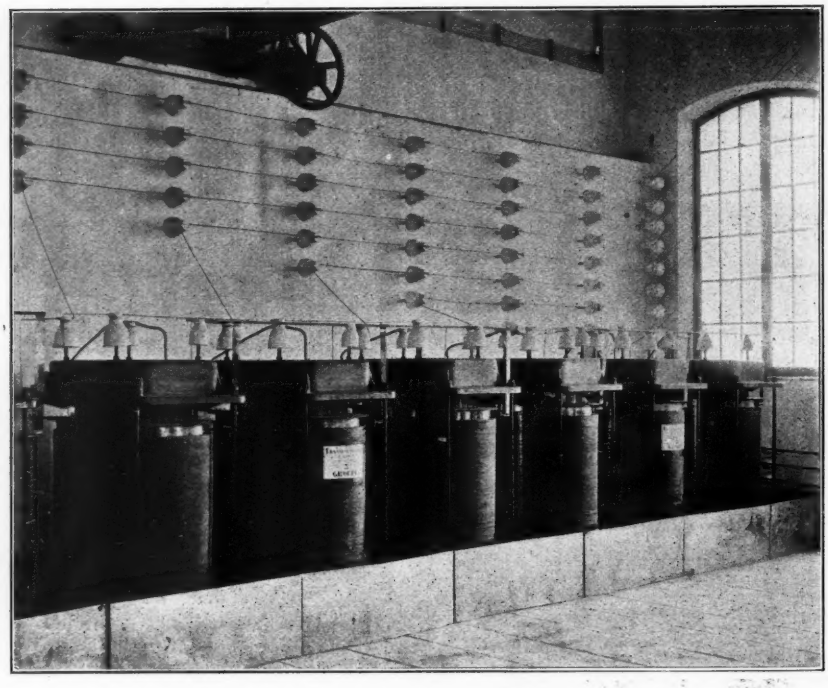


INTERIOR VIEW OF THE POWER-HOUSE AT ST. GEORGES, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

THE LOW-TENSION BRANCHES.

The low-tension branches include all the 5,000-volt lines. These lines differ only from the 20,000-volt lines in the use of a smaller insulator and a less distance

between the wires. Each branch is protected by circuit-breakers furnished with Siemens horns. The distributing station in each village contains a transformer, lowering the voltage from 5,000 to 125.

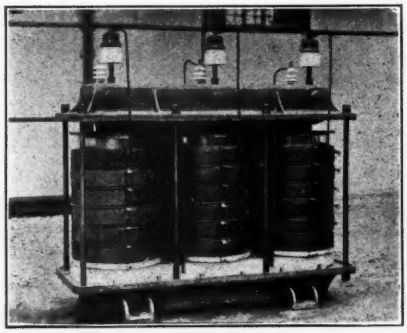


TRANSFORMER ROOM AT POWER STATION, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

No switches are provided for the high-tension side, the circuit-breakers serving for that purpose without difficulty. A low-tension switchboard of marble, with switches and circuit-breakers, controls the distribution of power and lighting to the village. Usually the capacity of the transformers installed in the village varies from ten to twenty kilowatts.

SUBSTATIONS.

At present there are two substations—that of Carcassonne and that of Narbonne. In addition to the distribution at 5,000 volts three-phase current for the factories and neighborhood, there was at these villages a constant-current three-wire system with a maximum potential of 300 volts between the outer conductors. These lines were fed by continuous-current generators driven by steam engines or turbines. Advantage has been taken of the three-phase system going from St. Georges, to install groups of motor-generators. Both at Narbonne and Carcassonne are two motor-generator sets with a capacity of 150 kilowatts, each composed of two synchronous Alioth motors of 225 horse-power, 500 volts, coupled directly to continuous-current generators, also of the Alioth make, giving 300 volts at 430 revolutions. To start these groups the generator is operated as a motor to bring the alternating-current motor to synchronism in the usual manner. When the line is not alive at the moment of coupling the first motor, there is a rise in voltage, but this does not take place when the continuous-current generator is loaded. If, on the contrary, the network is already charged, there is no rise in voltage. This rise in pressure reaches about 25,000 volts.



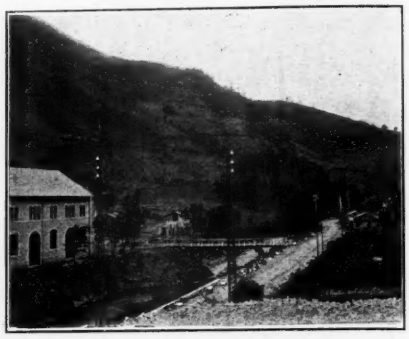
THREE-PHASE TRANSFORMERS, FORTY-SIX KILOWATTS, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

ELECTRIC MOTORS ON THE SYSTEM.

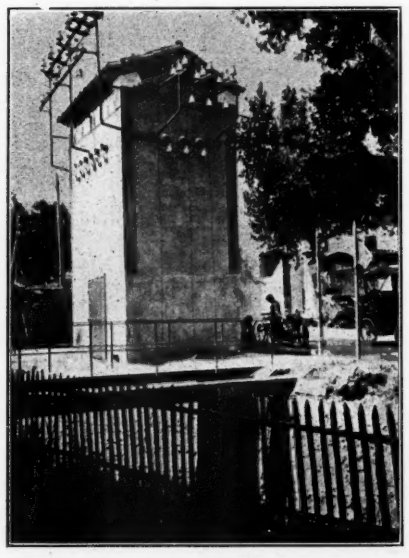
These are all, as well in the city of Carcassonne as in Narbonne, of the three-phase induction type. Starting is effected by placing a resistance in the rotor. This, for small motors, is fixed upon the end of the rotor, turning with it. As soon as full speed is attained, the resistance is short-circuited. In the cities of Carcassonne and Narbonne motors are, in general, connected to the continuous-current system, and operate at a tension of 250 volts.

OPERATION OF THE SYSTEM.

The employés are placed under the direction of a chief engineer, who has directly under his orders a superintendent of the line, living at the distributing station at Fabrazan, where he can communicate by private telephone with the generating station, and also by public telephone or telegraph with the other points of the network. The superintendent of the line has particular charge of the feeder which passes through the mountainous country, exposed to wind, and which for thirty kilometres (eighteen miles) could not follow the road. To aid in this care, the eight line inspectors mentioned above have been stationed along the route. The high-tension branches are under the care of two assistant superintendents of the network, who have also inspectors under their orders, but less in number than for the feeder, as these branches follow roads, and it is easy, by means of a bicycle or an automobile, to pass from point to point.



THE LINE, AUDE HIGH-TENSION TRANSMISSION SYSTEM.



TRANSFORMER HOUSE, AUDE HIGH-TENSION TRANSMISSION SYSTEM.

The substations at Carcassonne and

Narbonne have each a station superintendent, who has charge of the material of the substations and the lines in the cities. Finally, there are station superintendents in all the villages.

On account of peculiar conditions, the constructing company was limited to the expense of the generating station and the high-tension lines, all the rest being done at the expense of the various communities, in consideration for which municipal lighting is guaranteed gratuitously at the rate of twenty-five sixteen-candle-power incandescent lamps per 1,000 inhabitants. Lighting is made by contract, a sixteen-candle-power lamp being sold for thirty-two francs per year. There are no meters, except at Carcassonne and Narbonne. But, on the other hand, there are inspectors who do not allow more lamps to burn at a time in any installation than the number provided for by contract. A large part of the energy is sold for power, but, generally, the motors are idle at the time when lighting begins. These motors are used in many cases for raising water and usually each community has replaced the oil engine which it possessed by an electric motor. There are, further, many motors for irrigation, for pressing wine, for making ice, in breweries, and in other similar industries in that locality. The income since the beginning of operation has been considerable. It covers not only the expense of the installation, but, further, has assured a satisfactory return on the capital for the second year. Better results will be obtained by the company when the installation has been completed, and this will not be long delayed.

Apparatus for the Production of High-Frequency Currents for Medical Use.

High-frequency alternating currents have been used in treating various diseases, but some difficulty has been experienced in obtaining large currents at a low potential. Dr. J. C. Bowie, of Cardiff, Wales, has developed an apparatus for overcoming this difficulty, described in the London *Lancet*. It consists of a step-up transformer and a condenser, both submerged in oil, and a spark-gap. The terminals of the condenser are connected to a flat helix which forms the primary of a step-down transformer. A second flat helix forms the secondary, and from this the currents are led to the patient. The frequency is varied by varying the capacity of the condenser, by simply changing the distance between the plates. The voltage can be varied by varying the distance between the two flat coils. The range being from 40 to 100 volts. The current can be regulated from 0.1 or less to 1 ampere. With this apparatus a patient can be treated from ten to fifteen minutes without risk.

SMOKE AND THE DETERMINATION OF ITS DENSITY.[1]

BY ALBERT A. CARY.

If a speck of soot from a factory chimney strikes our hand, we may, perhaps, blow it off, but in case we attempt to rub it off with the other hand, we find a black greasy streak or smooch left behind, and one needing hard rubbing with soap and water to remove it.

A fleck of pure carbon will not stick thus tenaciously and it has not such a peculiar greasy feeling, so we must look for something else besides pure carbon in our soot.

Probably the simplest way to study the formation and composition of these small greasy flecks of "dirt," is to consider first the method employed in the manufacture of pure coal gas and the resulting products derived from it.

To simplify my description of the production of coal gas I offer the illustration shown in Fig. 1, which shows the apparatus used in its manufacture in a diagrammatic form.

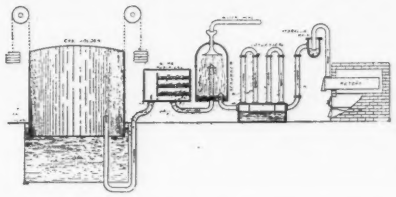


FIG. 1.—APPARATUS FOR MANUFACTURING COAL GAS.

In the gas house we find specially designed furnaces, containing a number of long ∪ shaped retorts into which the bituminous coal, used in making the gas, is placed. (The illustration shows but one of these retorts in the furnace.)

One end of each of these retorts is closed, while the other end (also closed) has an outlet A, termed the ascension pipe.

All of these several ascension pipes from one furnace are united together into one common header, out of which header leads a bent pipe (termed the dip pipe). The outer end of this dip pipe plunges downward under the surface of water contained in a long iron vessel, called the hydraulic main. The illustration shows a cross-sectional view of this hydraulic main.

Before proceeding further with the description of this apparatus, let us open a charging door at the end of the gas retort and introduce a quantity of bituminous coal, which may have the following chemical analysis:

	Per cent.
Carbon	82.32
Hydrogen	5.41
Nitrogen	1.35
Oxygen	5.69
Sulphur	1.34
Ash	3.89
Total	100.00

We then close our charging door, sealing it hermetically and build a fire upon the grate beneath the retort, and its heat will next drive off the volatile gases contained in the retorted coal without producing combustion (due to the absence of air).

After these gases have been thus driven off, we open our retort and find remaining a coke which is little over sixty per cent in weight of the original coal.

This coke consists of practically pure carbon, with the ash or non-combustible matter contained in the original coal.

We now have distilled off somewhat less than forty per cent of the original weight of the coal as gas and vapor, having an analysis approximately as follows:

	Per cent.
Carbon	25.54
Hydrogen	5.41
Nitrogen	1.35
Oxygen	5.69
Sulphur	1.34

The gaseous and vaporous product distilled from the coal which passes from the submerged dip pipe into the hydraulic main deposits a dirty, black, sticky or greasy substance known as coal tar and it also leaves behind ammonia water.

We have now found a clue in this tar which points to the reason for finding the atmospheric soot both greasy and sticky. It would be difficult to imagine any more persistent dirt (from a detergent standpoint) than exists in this tar, but its redeeming feature is found in the fact that it contains a large number of most valuable products, the beautiful analine colors being one derived from this source.

Analysis of this coal tar gives approximately the following composition:

	Per cent.
Carbon	77.53
Hydrogen	6.33
Nitrogen	1.03
Oxygen	14.50
Sulphur	0.61
Total	100.00

These elements in the tar are built up into about 140 different constituents, traces of which can be identified by the chemist. It is found to contain benzole, naphtha, naphthaline, anthracene, carbolic acid and pitch, which may be extracted by processes of partial distillation.

After leaving the hydraulic main, the remaining gas passes by the pipe B

[1] Abstract of a paper read before the New England Cotton Manufacturers' Association.

through a series of vertical pipes called a condenser and is considerably lowered in temperature. The gas after leaving the hydraulic main is by no means freed from all contamination, as we find in it a certain amount of vapor, sulphuretted hydrogen and carbon disulphide. When cooled in the condenser, it drops the last traces of liquid impurities and then to remove the sulphur compounds it is passed into the bottom of a scrubber, where it is made to rise through a shower of clean sprayed water in which all the compounds soluble in water are taken up, and then it passes into the lime purifier, consisting of a large and tight vessel containing a number of trays filled with slacked lime, and as the gas comes in contact with a large surface of this reagent, its remaining sulphur impurities are removed. The gas, now having passed through its entire purifying process, passes on to the gas-holder ready for use. The average composition of the purified coal gas will be:

	Per cent.
Hydrogen	47.99
Saturated hydrocarbons.	37.64
Unsaturated "	4.41
Carbon monoxide	3.75
Carbon dioxide	nil
Oxygen	0.26
Nitrogen	5.95
Total	100.00

The approximate proportion in which the products are obtained from a long ton of gas coal is as follows:

	Pounds.	Per cent.
10,000 cubic feet of gas	380	17.0
10 gallons of tar	115	5.1
Gas liquor (condensed from gas alone)	177	7.9
Coke	1,568	70.0
	2,240	100.0

The above described actions in the manufacture of coal gas, taking place as they do at a temperature of about 1,800 degrees Fahrenheit, and under conditions which result in heating the gases and vapors after they are liberated from the coal as they pass through the upper portions of the retort, are not dissimilar to the decomposition of a very thin layer of bituminous coal spread on the surface of an incandescent firebed, but as the temperature utilized to distill off these gases and vapors is lowered, the smaller will be the volume of gas evolved, following which rapid changes will take place in the composition and quantity of tarry vapors distilled off.

Professor Viviam Lewes, of the Royal Naval College at Greenwich, England, has investigated the smoke problem from a chemical standpoint very thoroughly, and as his words fit into this stage of our discussion most aptly I can not do better than quote from a paper on this subject written by him in 1895. (See English *Gas World.*)

"In placing a quantity of bituminous coal on a fire the decomposition will vary with temperature in every part of the charge, and an inch away from the live fuel the coal will be distilling off tar vapors rich in paraffin hydrocarbons, and yielding very little gas. Complex as are the changes taking place in the decomposition of the coal itself under the influence of heat, the further actions which take place when the products burn in contact with the air and other gases at the top of the fire are still more so, and are affected by the nature of the products from the coal, the amount of air present, temperature, and the diluting action of the products of combustion from the lower part of the grate. Stated in its simplest form, the hydrocarbons present in the gas and tar vapor reach the air above the fire diluted with nitrogen, carbon dioxide, carbon monoxide, and water vapor from the combustion in the lower part of the grate, and as soon as they reach the surface of the fuel are met by the rush of cold air drawn in by the chimney draft, the oxygen of which enables the combustible gases and vapors to burn, while the nitrogen still further dilutes and retards the actions taking place.

"All flame is caused by the combustion of gaseous matter. When the supporter of combustion is supplied externally to the combustible gas, such a flame is always hollow, and will consist of at least two parts, an outer part in which combustion is taking place, and the interior of the flame, which being cut off from the supporter of combustion by the burning envelope can obtain no oxygen to carry on the action. In an ordinary flame, such as is used for illuminating purposes, there are generally four distinct parts, but in such a flame as that obtained by the combustion of the gases and vapors escaping at the top of a fire, it will be sufficient to look upon it as consisting of two. The inner portion, although not undergoing combustion, is an active area of chemical change, as under the baking influence of the burning envelope which surrounds it the hydrocarbon gases and vapors are gradually broken down, the most important action being their conversion into the simple hydrocarbon acetylene, which contains twenty-four parts by weight of carbon combined with two parts by weight of hydrogen. In the outer envelope of the flame both the carbon and hydrogen compounds present are being consumed with formation of carbon dioxide, carbon monoxide, and water vapor. But in the flame certain other changes are observable to the eye. The dark inner zone, which we may look upon as a laboratory and gas store of the flame, is surmounted by a portion which is brilliantly luminous, and gives the major part of the cheerful fire light. Higher up the flame the luminous portion becomes dull red in color and gives out far less light, and above this again smoke begins to appear in considerable quantities. These gradations in appearance are due to the acetylene formed in the non-luminous core of the flame entering the heated zone of combustion, when the acetylene suddenly splits up into carbon and hydrocarbon, the latter of which burns and adds to the general heat of the flame, while the carbon, raised to incandescence, partly by heat generated during its own formation from acetylene, partly by heat from the flame, and partly by its ultimate combustion, gives out the light. If sufficient oxygen were supplied to complete the action, no smoke would escape from the flame, and a far higher power of radiating light and heat would be produced; but one finds in practice that the diluting influence of the nitrogen and other products from the fire beneath, and the cooling influence of the chimney draft which comes in contact with the flame, so check and hamper the completion of the combustion of the products from the decomposition of the acetylene, that you have the top of the flame cooled to a dull red and the flame finally extinguished before the carbon particles can be consumed, this leading to the sooty smoke which passes up the chimney.

"It must not be inferred from this that the smoke which pollutes our atmosphere is entirely formed in this way. But the black particles of carbon which form the soot in the chimney and the blacks which float in the atmosphere are nearly all thus produced, the remainder of the smoke consisting of undecomposed tarry vapors, and the steam which is abundantly condensed from the water vapor produced as one of the primary products of combustion.

"If we take the smoke from a cigar or from a cigarette and blow it into a thin glass chamber highly illuminated from below by focusing upon it the beams of an electric lantern or lime light, and examine it under a high-power microscope, it presents a most remarkable and wonderful appearance. Such smoke contains no particles of free carbon, but appears to consist of an immense number of little

round particles in the wildest condition of commotion and movement, each particle rushing about and never coming in contact with its neighbor. Indeed, it presents as beautiful a picture as one could imagine of the molecular movement with which theorists have endowed matter. On still further examination these little particles prove to be tiny vesicles, the skins of which are formed of condensed vapor and liquids from the burning substance which give rise to them. These vesicles, being filled with gases, are excessively light, and float in the atmosphere until brought forcibly in contact with some surface, which causes them to burst and deposit the liquid film, so setting the contents free.

"The tar vapor which escapes during the distillation of coal, either in the gas maker's retorts or upon an open fire, consists of a mass of vesicles of this character. When the temperature at the top of the fire has been sufficient to ignite the gas escaping from it, they are not formed, and under these conditions only a small portion of the escaping smoke is of this character, the smoke being chiefly carbon particles. When the fuel has been put on in sufficient quantity to cool the top of the fire below the ignition point of the gas, the smoke which escapes consists chiefly of steam and of the tar cloud; while all smoke contains dust and ash from the grate.

"It will be seen from this description of the formation of smoke that there are four sets of particles forming it. (1) Carbon particles escaping unconsumed from the burning hydrocarbons, and giving the soot. (2) Tar vapors. (3) Steam. (4) Small particles of dust mechanically carried up by the draft. The proportions in which the four occur in the smoke are entirely dependent upon the condition of the surface of the fire. When the fuel is first put on, tar vapor and steam only escape from the fire below, together with the products of complete and incomplete combustion, among which you have carbon monoxide. As the heat works upward through the new fuel, the products of distillation from the coal catch fire and are partially burned, the result being that the deposited carbon or soot also forms a portion of the smoke, while as the fire burns clearer and clearer, and the upper portion becomes incandescent, practically nothing but the products of complete combustion find their way up the chimney."

From this clear description of Professor Lewes and from the description of the manufacture of pure coal gas we have now obtained a good idea of how smoke is formed and what its solid and vaporous matter may be composed of, which information will be found useful, not only in our consideration of smoke nuisance problems, but also in considering smoke washers and "annihilators," whose inventors and manufacturers claim that considerable returns can be made by utilizing the residum, resulting from their cleansing process.

We will now turn our attention to methods that have been used in determining the density of smoke as it issues from the chimney to enable us to make more or less accurate determinations of the results obtained by any of the smoke-suppressing methods used in connection with our furnaces.

Probably the only accurate method for determining the quantity of free carbon, tarry matter and ash or dirt contained in the smoke is to properly withdraw a sample of the escaping products of combustion from the boiler outlet and carefully separate the solid from the gaseous matter, and after noting the internal capacity of the vessel which held the sample of gas with the weight of its solids, we can easily calculate the weight of the solids contained per cubic foot of gas.

The process is a difficult one when properly conducted, and beyond the ability of a man who has not had the careful training of a physicist or chemist.

Several methods have been used for directly collecting the soot, etc., on flat metal plates suspended in the path of the escaping products of combustion, some smeared with a sticky substance and others having no specially prepared surfaces, but depending upon the sticky, tarry vapors present to cause the soot to adhere.

Such plates are allowed to remain in place for a definite period of time, and the weight before and after such immersion in these gases is noted, the difference giving the quantity of soot, etc., collected during this period. In other tests of this kind the soot is brushed off the plate by use of a wire brush and weighed separately.

Such tests are only comparative, the plate being placed in the flue during the test of one set of conditions, and then after cleaning it is replaced in the flue for the same priod of time during the boiler's operation under another set of conditions, and the various results of soot accumulations are finally compared.

The camera is sometimes used in smoke determinations, photographs being taken of the escaping furnace products periodically, and the shades produced in the prints are compared. This is a misleading method for determining the density of smoke, as the position of the camera as regards the sun, the state of cloudiness of the sky, the method of developing and printing all lead to variable results.

The Prussian Smoke Commission of 1894 used a very elaborate method for determining smoke density which, although approximating accuracy, is too refined for the average observer.

Its apparatus included a photometric instrument (such as is used to determine the candle-power of all illuminants). Two openings were made by them on the opposite sides of the boiler flue carrying the soot-laden products of combustion, and the eye placed near one opening observed the appearance of the flame of a standard candle placed behind the opposite opening, and this candle's brightness (*i. e.*, the dulling of its brilliancy) was compared with the flame of a standard candle according to the usual method of making photometric measurements.

Probably the oldest and most widely used method for determining the density of smoke is by direct observation.

For this purpose the observer takes a position where he can easily watch the smoke issuing from the chimney and in order to describe the results found, he must adopt some standard of density, in order to properly express the various shades of color of the smoke, and he should also note the length of time that each of these shades exists.

It will be readily seen that such a system of observation, made with nothing but the observer's sense of discrimination to help him form an opinion of the smoke's density, will lead to extremely variable results; one man's idea of density differing materially from another's. The writer has known where two or more men have been stationed at different points of observation in order to eliminate the personal equation as much as possible, the results obtained by these separated observers being finally averaged.

Different results are obtained even by any one of such observers when he watches the smoke under different conditions, such as looking toward or away from the sun; looking against a clear blue sky or against a bright white cloud, or else against a dull dark cloud. It is almost impossible to avoid a comparison between the smoke and its background, so it is well for such an observer to adopt a similar position for all observations (as regards the position of the sun) and also to see that his cloud background is approximately always the same.

(To be concluded.)

COMPARISON BETWEEN STEAM AND ELECTRICALLY DRIVEN AUXILIARY PLANT IN CENTRAL STATIONS.[1]

BY C. D. TAITE AND R. S. DOWNE.

That the subject embraces a wide variety of machinery may be seen at once from the following list of auxiliary plant to be found in the majority of stations of fair size, and which are driven by steam engines or electric motors:—

Air pumps for condensers, cranes, feed pumps, mechanical stokers, economizers, coal elevator, ash conveyor, workshop.

During recent years it has become the practice to use electric motors almost exclusively for driving the greater number of the above adjuncts of the generating station; for instance, cranes, stokers, economizers, coal elevators, ash conveyors, and workshop are generally now found driven electrically; but condenser air-pumps and also feed-water pumps still adhere to a large extent to steam power; the latter two auxiliaries are running continuously, the running of the others being of an intermittent character. It is, however, becoming increasingly recognized that, quite apart from the power required for driving the plant, the loss from condensation in long ranges of steam piping which are rendered necessary when steam auxiliary plant is used is quite appreciable, and compares badly with the small amount of power absorbed in the cables of an electrical installation. Another important advantage which electrical methods of driving have over steam power is the ease with which the power taken in the former can be measured, while in the case of steam it is next to impossible to state definitely what is the percentage of power absorbed by the auxiliary plant. In the new generating station of the Salford corporation, where the whole of the auxiliary plant is driven electrically, it is found that the percentage of power absorbed by the auxiliary plant varies from 8.3 per cent to 6.5 per cent of the total power generated, according to the state of the load factor; it is clear that the better the load factor the lower will this percentage be reduced. The following figures are those of an average week taken from the station records:—

TABLE I.

		Percentage of Units Generated.
Units generated....	148,851	....
Units used on works	9,687	6 50
Made up as follows:		
Condensing plant...	6,962	4.67
Boiler feed pumps..	1,758	1.18
Mechanical stokers..	555	0.37
Ash conveyor.....	110	0.07
Economizer scrapers (1,600 pipes).....	157	0.11
Coal elevators	76	0.05
Workshop.....	65	0.05
Engine room crane..	4	....

[1] Abstract of paper read at meeting of the Manchester local section of the British Institution of Electrical Engineers on April 7, 1903.

The power taken by the mechanical stokers represented 1.04 units per boiler-hour, which is a rather higher figure than that obtained in many previous weeks, while the economizers required 0.33 unit per hour for driving the scrapers for each battery of 400 pipes; the coal elevators absorbed 0.22 unit per ton of coal raised forty feet and deposited in the bunkers. The load factor for the week was 39.1 per cent

$$\left(\frac{\text{Units generated} \times 100}{\text{Max. load} \times \text{number of hours in week}}\right);$$

as all the power circuits in the works are metered, it will be seen at once how easily one can check the whole of the power taken by the auxiliary plant when that plant is driven electrically; if in any week abnormal figures are obtained, it is a very simple matter to find the cause, as the weekly or even daily returns show clearly on which plant the abnormal consumption is taking place. This fact in itself tends to promote economy, as one soon finds out whether the plant is giving the duty that may fairly be expected from it; a standard of efficiency can thus be set up beyond which the plant must not be allowed to fall.

To turn now from a general comparison to an individual case, it will be generally admitted that there is no more important auxiliary plant in a generating station than the feed pumps; for, unless the pumps are reliable and trustworthy, the supply of steam for the main engine can not be guaranteed. It is, therefore, a matter of the utmost importance to make a correct choice of the type of feed pump.

The points which have to be considered are: (1) Reliability; (2) economy in working; (3) first cost; (4) upkeep.

RELIABILITY.

Provided that the plant is ordered from experienced firms, there need be no doubt about the reliability of feed pumps, whether they be driven electrically or by steam; both types are equally satisfactory on this score. Those who have any doubt as to the absolute reliability of electric motors have only to consider the case of the tramcar motor, which is working under the most difficult and trying conditions, yet a breakdown of a tramway motor is quite a rare occurrence. How much more reliable, therefore, should a pump motor be which is working under conditions so much more favorable. Nothing more requires to be said to show that, whether the pumps be driven by steam or by electricity, there need be no question as to any want of reliability.

ECONOMY IN WORKING.

Owing to the nature of the work which they have to perform, steam-feed pumps can never compare in efficiency with the main engines installed in the generating station for generating electricity. One well-known firm of pump makers states the steam consumption of its standard 6,000-gallon pump to be as follows:

TABLE II.

Gallons Delivered.	Pounds of Steam Used per Hour at 180 Pounds Pressure.	Pounds of Water Delivered per Pound of Steam Used.
1,000	130	77
2,000	253	79
4,000	490	81.5
6,000	714	84

Tests have been carried out at Southport on pumps which have been in use for three or four years, and the following was the average result of several tests, each extending over twenty-four hours under ordinary working conditions:

Pounds of water delivered per pound of steam used 49.1.

The pumps had been recently thoroughly overhauled and fitted with new pump rings; the great discrepancy, therefore, between the figures obtained and those given by the pump makers must be due to the intermittent character of the load.

At the Salford station tests have been carried out on an electrically driven 4,000-gallon pump with the following results:

TABLE III.

Gallons Delivered.	Duration of Test.	Units Used.
(1) 8,971	4 hours	27.6
(2) 15,822	4 "	36

If each unit is taken as requiring thirty pounds of steam to generate it, which is more than twenty-five per cent above the full-load consumption of the steam engines installed, the above figures may be stated as follows:

TABLE IV.

Gallons Delivered per Hour.	Pounds of Water Delivered per Pound of Steam Used.
2,240	108
3,955	147

Comparing these figures with the figures given above, it will be seen at once how greatly superior the electrically driven pumps are from the point of duty per pound of steam than are the steam pumps, and this too in spite of the fact that the full-load overall efficiency of the electrically driven pumps was only 60.67 per cent. The motor in this case was coupled to the pump through worm gearing, which at the time of the test was,

comparatively speaking, new, and which is certainly giving better results now. The ratio of the gearing is twelve to one. It would be interesting if some one could give particulars of tests of pumps electrically driven through spur gearing or by other means.

With regard to the figures obtained at the Southport works, it will be seen that they compare very badly with the electrically driven plant, and on the basis that the latter absorbs 1.18 per cent of the total output of the station, the former must be requiring from two and one-half per cent to three and one-half per cent of the total output.

The figures given by the pump makers are interesting as showing how slight is the increase in efficiency of a steam pump from light load to full load. The electrically driven pump, on the other hand, delivers thirty-six per cent more water per pound of steam at full load than it does at half load. This points to the desirability of a careful subdivision of plant where electric motors are adopted.

FIRST COST.

With regard to the money value of the saving in power, this varies directly with the price of fuel, and inversely as the first cost of the plant. In Lancashire, where good slack can usually be obtained for 8s. 6d. to 9s., the money value of the steam saved is less than half what it would be in London and south-country towns, where fuel ranges from 20s. to 30s. a ton.

Still, taking again the Salford figures, one per cent of the present annual coal bill represents £60, and to put the saving in fuel at this station due to the use of electrically driven pumps instead of steam pumps at £100 per annum is a conservative estimate. Against this saving has to be set the additional interest and sinking fund due to the extra cost of the electrical pumps; say, for a 5,000-gallon pump, £330, against £125 for a steam pump; allowing six and one-half per cent in each case and the provision of three pumps, the difference per annum would be £40, which reduces the money value of the saving to £60. This may seem a small sum, but it should be remembered that it represents the minimum saving.

UPKEEP.

With regard to the question of upkeep there is little, if anything, to choose between the motor-driven pump and the steam pump, provided that both are well looked after and kept in a proper condition. Care, however, must be taken to see that the delivery range attached to the pumps is provided with a relief valve of ample area to prevent any damage occurring, even should the fireman close all his feed valves; otherwise the effect would be to cause a fracture either of the pipes or the pump casing.

The case, therefore, with regard to feed pumps may be summed up as follows:

1. Reliability—Both types equally reliable.
2. Economy in Working—The electrically driven pump shows a great superiority.
3. First Cost—The electrically driven pump costs about three times as much as the steam pump.
4. Upkeep—Both types satisfactory.

Generally speaking, the authors are in favor of electrically driven feed pumps, particularly in localities where coal is dear. Where such pumps are used, and, in fact, where any electrically driven auxiliary plant is extensively adopted, the authors consider that a battery of accumulators is a practical necessity, as in the event of a total breakdown of the generating plant from any cause, the supply of water to the boilers and the lighting of the works would not be interrupted.

Turning now to the consideration of condensing plant, it will be seen from table I that the condensing plant at the Salford works absorbs no less than 4.67 per cent of the total output of the station.

The plant consists of eight sets of jet condensers, each provided with an Edwards three-throw air-pump driven electrically through double-reduction spur gearing. Each condenser deals with the steam exhausted from a 1,200-horse-power engine, and the water for condensing this steam is drawn from the Manchester, Bolton & Bury Canal. One of the conditions being that the temperature of the discharge water shall not exceed ninety degrees Fahrenheit, it is frequently necessary to use a rather excessive amount of circulating water. The percentage of power taken by the condensing plant when the engine is working fully loaded is 2.4 per cent. This compares with one and one-half to two per cent, which is the usual allowance when the air-pumps of a jet condenser are driven direct from the main engine as in mill work; the latter practice is undoubtedly the most economical, as the losses in the dynamo and motor are both saved; but with the modern high-speed engine a direct-coupled condenser is, generally speaking, impracticable, and the choice lies between a separate steam engine and an electric motor. The latter is generally the most convenient to adopt on account of cleanliness and small space required, but the advantage with regard to economy in power rests, if anything, with the steam plant run condensing. Where surface condensers are used the conditions favor the use of electric motors, and the authors recommend their more frequent adoption.

At Southport interesting figures have been obtained in connection with the use of single-phase alternating-current motors driving Gwynne centrifugal pumps for raising water for Korting evaporative condenser. The total lift is thirty-five feet, the volume of water lifted is 60,000 to 66,000 gallons per hour per engine, and the horse-power of the motors is thirty-five British horse-power; the engines to which the condensers are attached are of 1,000 horse-power; during a three hours' run the alternator generated an average of 510 kilowatts per hour, full load being 600 kilowatts, and the motor pump took 29.6 units per hour, 5.8 per cent; the percentage power, however, during the evening's run, averaged as much as 7.26 per cent of the units generated. As the condensing plant requires a constant supply of water irrespective of the load on the engine, it is evident that when the alternator is generating its full load (600 kilowatts), the percentage of power taken by the condenser would be reduced to 4.93 per cent, still a high figure.

A last example of an electrically driven plant is a motor-alternator set at the Salford Corporation Works, used for supplying the outlying districts with alternating current. There are two sets in duplicate, each consisting of a 150-kilowatt direct-current motor, direct-coupled to two 120-kilowatt alternators, the latter of an old-fashioned design, having been built in 1894. The two sets are never run together except for the purpose of changing from one to another; one set just takes the full load every night, but during the daytime the load is very light. The average daily efficiency, taken over several weeks in the winter, amounted to only seventy-two per cent, the load-factor of the plant being thirty-five per cent; the maximum full-load efficiency is eighty-four per cent. This example is given to show the care which must be taken in designing a direct-current supply from an alternating-current generating station when a reasonable efficiency is to be obtained.

A few figures relating to eleven months' working of the auxiliary plant at Salford may be interesting. The total units used during this period by the auxiliaries amounted to approximately 410,000, equivalent to seven per cent of the total units generated; as the cost of fuel is just 0.25d. per unit generated, the money value of the units is £427. There is no doubt that the auxiliary plant is partly responsible for the low coal cost per unit generated, as it has helped to improve the load-factor very materially. This improvement of the load-factor by using electrically driven auxiliaries is an important point, and one that has a considerable bearing on the subject.

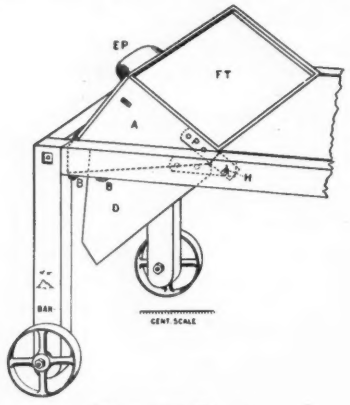
Managers of electricity undertakings spend a large proportion of their time in advocating the adoption of electric motors in the interests of the consumer, and with a view of improving the station load-factor; consequently, it is essential that wherever possible they should arrange for electrical driving on their own works.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLV—ON REFLECTING CRYPTOSCOPIC CAMERAS.

I described and illustrated the first reflecting cryptoscope and the first cryptoscopic camera in the *International Dental*

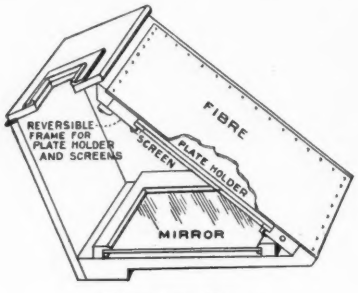


NOTE 155—FIG. 1.

EXPLANATION OF CUT.

A—Reflecting cryptoscopic camera in position.
D—Camera turned down out of the way.
P—Metal bar fitting over axis. H, enabling the camera to be removed from the examination table.
B—Button holding camera in position, A.

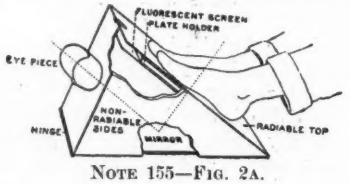
Journal for July, 1896, or almost seven years ago, yet these instruments are not in use by others. In note xlviii, I described and illustrated a cryptoscope of



NOTE 155—FIG. 2.

Perspective view of interior of a reflecting cryptoscopic X-light camera.

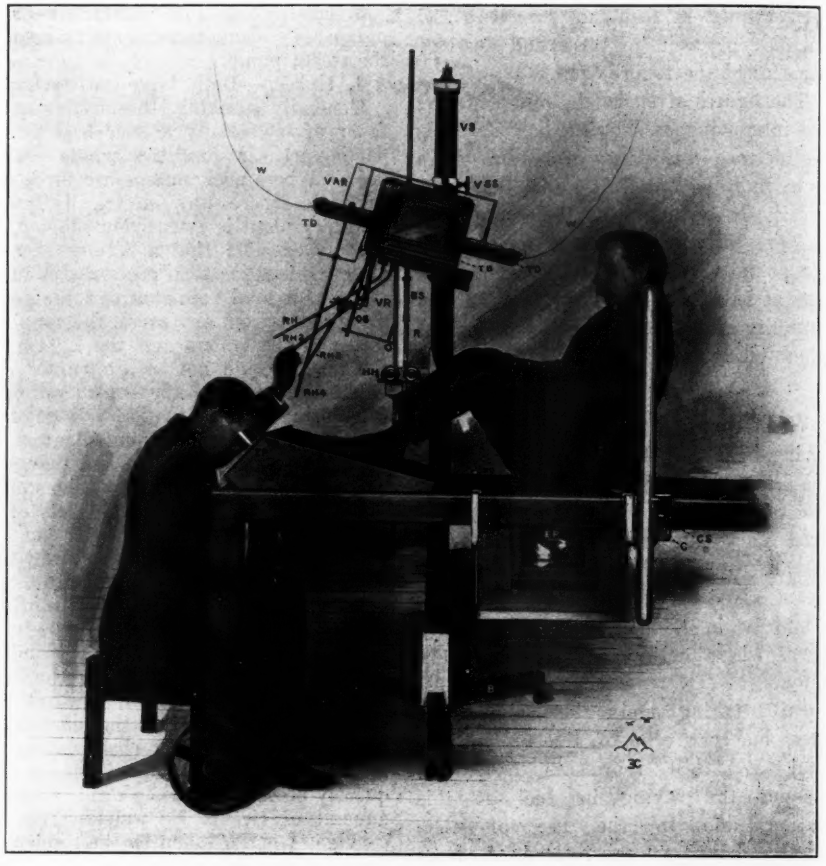
this type which enabled the observer to see and hear the sounds of his heart and lungs. Since 1896, I have made a number of types of reflecting cryptoscopes and



NOTE 155—FIG. 2A.

Reflecting cryptoscopic camera for X-light signalment of the feet.

cryptoscopic cameras and have found them useful. Therefore one more attempt will be made to attract attention to them. Two instruments of this type are illustrated in this note. They are intended to enable the observer to see the image on the screen when the source of light is above the patient, the photographic plate or the fluorescent screen being below. Ordinarily with the light in this position the image on the screen could not be seen as the observer would not care to get under the table. We ought to see the image on the screen to arrange the position, distance and direction of the light, and to find where the image of my orienter strikes the screen that it may appear on the negative in proper relation to the image of those parts of the patient which are being photographed. (See axioms in note cxlviii.)



NOTE 155—FIG. 3.

Reflecting cryptoscopic camera in use for photographing the feet for signalment by X-light. The observer has within reach, while looking in the camera, six handles, two of which, H and HH, regulate the distance of the source of X-light and allow it to be moved in a horizontal plane. Taken in connection with rolling movements of the examination table they enable the source of X-light to be quickly brought into proper relations with fluorescent screen. Handle RH4 controls the quality of the X-light. Handles RH and RH3 enable the opening of the diaphragm and the orienter to be centered with the source of X-light. Handle RH2 regulates the size of the area of the patient illuminated. This illuminated area must be as small as possible to avoid injuring the definition of the image on the screen and on the photographic plate. For further explanation of the letters refer to descriptions under the illustrations 1 and 4, note clvi, and to the text of notes cxlviii, cxlix, cl, cli, clv.

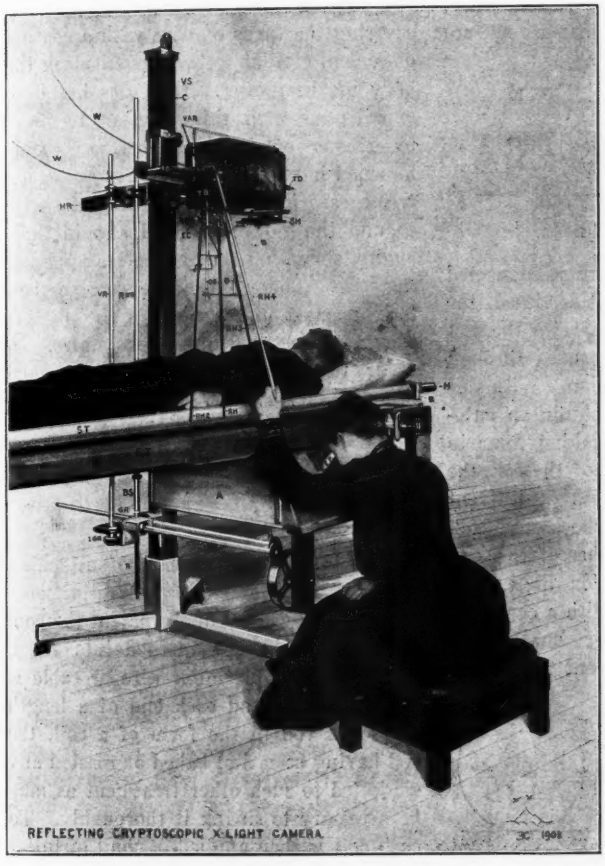
Also we need to see the image on the screen while the photograph is being made to know how long an exposure to give, and if the exposure is of some length, to keep the light properly adjusted to bring out details in the tissues. The first camera to be described was used in my method of anthropometrical signalment mentioned in note clvii.

The person who is to be signalized is placed on the examination table shown in Fig. 96, March 9, 1901, and in the figures of note cxxxix. Instead of the plate-holder there illustrated a reflecting cryptoscopic camera is used. The top of the camera (Figs. 1 and 2) is made of a thin layer of the material known to electricians as fibre. The remainder of the camera is of wood, painted on the inside with white lead until the walls are non-radiable. There is a recess directly below the fibre top for the insertion of the plate-holder, while below this is the fluorescent screen. By an arrangement of springs the fluorescent screen is pressed against the fibre top, but when the plate-holder is inserted the screen is pressed down until the plate-holder occupies the same position as that of the screen when the arrangements of the distance of the light were made (Fig. 2). At the same time the screen remains below the plate-holder, enabling the X-light which comes through the plate-holder to make the image on the screen. The springs also serve to press the plate-holder against the fibre. The eye-piece belongs with the cryptoscope shown in the figures in note cxlv, and fits all the cryptoscopes and cameras. The observer (Fig. 3) looks through this eye-piece to the mirror, where he sees the image of the feet on the screen, whether the plate-holder is in

place or not. He therefore can adjust the light and the position of the feet before the photographic plate is put in the camera. In former notes, it was shown that the plate-holders should be constructed on a new plan, of non-radiable material except in front where the direct X-light entered. In using a reflecting cryptoscopic camera constructed of non-radiable material the plate-holder does not require a non-radiable back, for that part is protected from the diffused X-light in the room by the walls of the camera. In a plate-holder for a cryptoscopic camera the back of the plate-holder should be made of radiable material to allow the X-light after passing through the plate-holder to strike the fluorescent screen to enable the observer to watch the object being photographed. Rœntgen said zinc reflected X-light, therefore I used zinc backs to some of my plate-holders for reflecting cryptoscopic cameras; for while this metal is sufficiently radiable for the purpose, its reflecting property may shorten the exposure of the photographic plate. Plate-holders of this kind are not illustrated here, as they differ from the ones shown in earlier notes only in the construction of the back, which may be of zinc or aluminum. It is evident with the form of camera here mentioned for use in photographing the feet no plate-holder is required, as the plate being protected by the fibre front of the camera may be used in the ordinary paper envelope, but in the next form of camera a plate-holder is desirable to allow the plate to be used either outside or inside of the body of the camera.

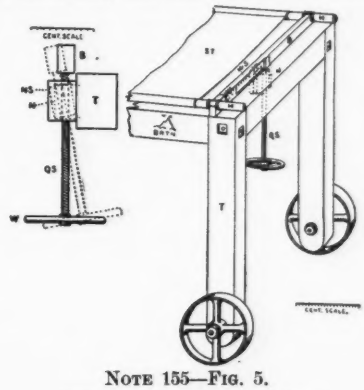
In using the X-light for anthropometrical signalments it is essential that the source of X-light should occupy a constant position in regard to the part of the body to be photographed. In case of the feet, I recommend having the central ray strike the plate at a point between the feet and opposite the joints between the metacarpal bones of the great toes and the internal cuneiform bones. In signalitic measures of the feet by X-light I recommend placing the source of X-light at a distance of seventy centimetres from the photographic plate with the distance finder at half this distance. With the parts properly arranged the image formed by my orienter will be a square of a diameter of eight centimetres with a circle in the centre. As the parts of the orienter (consult note cxvii, March 9, 1901, and notes cxliii, cxlviii, cxlix, cl and cli) are non-radiable, their images appear on the negative with the images of the bones. The negative therefore contains evidence of the position and distance of the source of X-light, as well as the angle at which the central ray struck the plate. The second camera (Fig. 4) to be described has the same general construction. It is hung from the side rails of the examination table, along which it can be rolled to bring it under any part of the patient who is in a horizontal position on the stretcher. For use it is brought into approximately the correct position. The observer then looks into the eye-piece, seeing on the mirror the image of the shadow of the patient's organs formed on the fluorescent screen. By means of the various handles (consult notes cxlviii, cxlix, cl, cli and clvi) connected with the tube box and stand the light is brought into proper relations and made of the right quality. The photographic plate can then be inserted as in the first camera or it may be placed on the top of the camera in contact with the stretcher, one end of which is lifted to permit of its insertion. A lifting mechanism for the stretcher has been figured in former notes. A better one is shown in Figs. 5 and 6 here. Each end of the stretcher is held in bronze bars, one of which is shown, B. This bar is in two pieces, which can be separated by turning the milled head, MH, Fig. 6, which acts on the screw S, forcing the two pieces apart. This enables the canvas of the stretcher, ST (Fig. 5), to be made as taut as desired. To lift one end of the stretcher in order to place the patient at an angle with the horizontal, a wheel, W, is turned, bringing into action the compound screw, QS, one end of which is permanently attached to the bronze bar, B. This arrangement is practical and strong. The stretcher can be removed at any time by lifting it out of the notches in the bar. Further explanations of Figs. 5 and 6: H, handles of stretcher; T, section of end bar of examination to which the nut, N, of the screw, QS, is attached; ST, steady pins; TS, screw forcing the two pieces of bronze bar apart. (See also Fig. 7, note clvi.)

Other forms of cameras in which a cryptoscope and camera are combined, intended to be used when the light is below instead of above a patient, will be described later. As they do not contain the reflecting principle, they do not properly come under the title of this note.



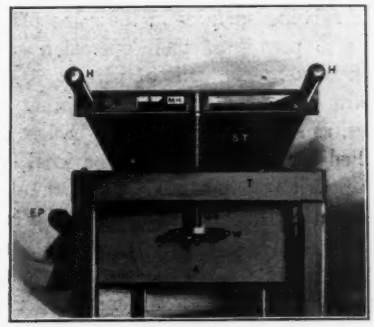
NOTE 155—FIG. 4.

The figure shows a reflecting cryptoscopic camera in use for photographing the spine, the patient being in a horizontal table position on the stretcher, ST, of the examination table ET. The observer looks into the eye piece, EP, of the camera, A, and sees on the mirror an image of the spine made by the X-light on the fluorescent screen at the top of the camera directly under the patient. It will be observed that the stretcher is slightly raised at the head to bring the axis of the spine as nearly parallel with the screen and consequently with the photographic plate, the tube box being also slightly turned in a vertical plane to bring the central ray of X-light normal to the plate. By means of the handles, HH, H, RH, RH2, RH3, the direction of the source of X-light and the size of the illuminated area of the patient can be controlled by the observer while making the examination. The quality of the X-light is controlled by the handle RH4. For further explanation of the letters refer to the description under Fig. 1, note clvi, and to the text of that note.



NOTE 155—FIG. 5.

Lifting mechanism for stretcher.

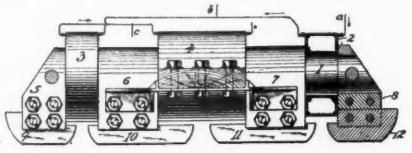


NOTE 155—FIG. 6.

Lifting mechanism for stretcher.

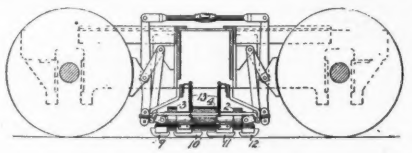
Electrical Patents.

A patent obtained by Mr. Frank C. Newel, of Wilkinsburg, Pa., on a novel electromagnetic brake has been assigned to the Westinghouse Air Brake Company, of Pittsburg, Pa. The invention comprises a multipolar electromagnetic brake device with a plurality of energizing coils by which the braking force may be varied and which is specially adapted to be connected in a local circuit with one or more motors on a car which when the brakes are applied act as generators to supply current to the local circuit; but its employment is not limited to such connection, as it may be employed where the current is obtained from the main or trolley line or from a battery. The improved electromagnetic brake device is specially advantageous as a track brake or in any application in which the limited capacity of the armature would, with other construction, limit the maximum braking force. For example, in a brake system in which a bipolar magnet is applied to a rail which acts as an armature the force with which the shoes of the magnet may be held to the rail is limited by the cross-section of the rail, which can not be increased merely for braking purposes, and it is a special object of the invention to provide means whereby in such case the braking force may be increased to any desired degree and varied either automatically or at will. In the embodiment of the invention shown in the accompanying cuts, the electromagnetic brake device consists of a multipolar magnetic device with multiple windings, having a core, 1, on which are wound, in this instance, the three coils of wire, 2, 3 and 4, and which is provided with polar extensions, 5, 6, 7 and 8, to which are attached the brake shoes, 9, 10, 11 and 12, arranged with their rubbing surfaces in the same plane, so as to permit of their operation as a track brake. The coils of wire, 2, 3 and 4, are connected with one another in series, as shown, and when the brakes are applied they are connected in a local circuit with the motor, as shown in the diagrammatic view, the field coil of the motor being represented by the coil, F, and the armature by the circle, A, so that the motor, acting as a generator, may then deliver current to the magnet coils. The magnetic brake device is suspended from the frame of the car by means of springs, 13, and when a current is passed through the coils the shoes are attracted to the rails and the friction between the shoes and the rails resists the movement of the car and causes the magnetic brake device to be moved backward relative to the car with a dragging action, so as to cause the application of the wheel brakes. An important feature of the invention consists in the means by which the braking force may be varied, either independently of or in accordance with the speed of the car. For this purpose the brake magnet device may be formed with any desired number of poles and with a corresponding number of coils of wire so wound and connected that the magnetic force may be varied by varying the effect of one or more coils. As shown, the brake magnet device is provided with four poles, and between the polar extensions are



ELECTROMAGNETIC BRAKE.

three coils of wire which are so connected that when the local circuit is closed, the coils are connected in series with the motor, so that the current passes through each of the coils in succession. With this arrangement, in order to obtain an automatic regulation of the braking force in accordance with the speed of the car, the three coils are wound with a different number of turns of wire, the largest coil, 4, having a sufficient number of turns to produce magnetic saturation at a comparatively low speed and with a comparatively small current, the next smaller coil, 3, requiring a greater current for saturation, and the coil, 2, requiring a still greater current. When the car is moving at a high rate of speed and the motor is generating a corresponding current, each of the coils will receive sufficient current to produce magnetic saturation of its core, and the attraction between the shoes and the rail will then be a maximum; but as the speed of the car reduces the current generated by the motor acting as a generator will be correspondingly reduced and also the magnetizing power of the coils. As the speed of the car and the strength of the current continue to decrease, the energizing effect of the coils will be successively diminished, so that at one speed the current in the coil with the least number of turns will be insufficient to energize its core so as to produce any considerable effect, and as the speed and the current are further reduced the current in the coil with the next number of turns will become practically ineffective, and so on until the car stops and no current is being generated.



ELECTROMAGNETIC BRAKE.

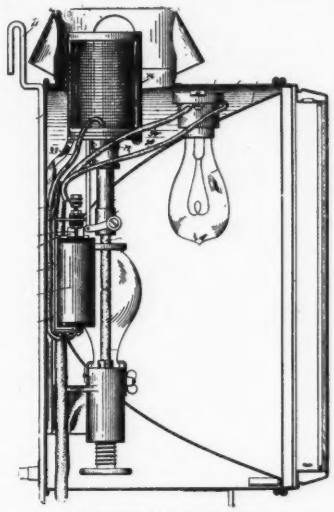
In the manufacture of glowers for Nernst lamps it has been attempted to provide wire terminals for attachment to the circuit terminals of the lamp, by winding a platinum wire or twisted strands of such wire about each end of the glower body, then twisting together the free ends of the wires, and finally covering the turns of wire with a coating of cement similar to that constituting the body of the glower. Difficulty has been experienced with this form of terminal by reason of its tendency to become loosened in service, particularly unless extreme care is taken in winding the wire around the glower rod and also in thoroughly shrinking the rod before applying the wire. These difficulties were particularly marked in cases where the glowers were manufactured in large numbers. In order to obviate these difficulties, Mr. Marshall W. Hanks, of Pittsburg, Pa.,

ELECTRIC LAMP GLOWER, AND METHOD OF ATTACHING TERMINALS THERETO.

has devised a new method of attaching terminal wires, and George Westinghouse has obtained control of the patent thereon. In carrying the new method into effect, a portion of a platinum wire or cable is first wound around each end of a length of glower rod in the form of a coil, the rod having been first baked or roasted and subjected to such other treatment as may be necessary to shrink it thoroughly. To each coil is then applied a small quantity of copper or other material which will flux or alloy with the platinum, the same being heated to a high temperature by means of a suitable flame. The preferred manner of applying this copper is to hold one end of a copper rod or wire in contact with different portions of the coils, and simultaneously subject the parts to the flame of an oxyhydrogen burner. It may be applied, however, in powdered or comminuted form prior to the application of the flame. After the turns of wire have been thus treated, they are coated with a body of paste of a material similar to that of the rod, and the whole is then baked or roasted in accordance with the usual practice. The intense heat produced by the glower in service apparently volatilizes the alloying material which has

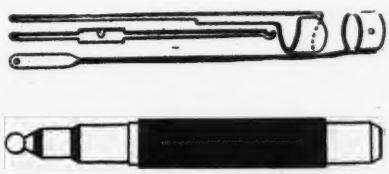
been applied to the turns and leaves a spongy platinum contact between that portion of the platinum which is not alloyed with the copper and the glower rod, and this contact is so close and firm that it is peculiarly efficient in service. Only a small amount of copper is necessary, since it is desirable to have the alloy extend only a short distance into the glower rod and the coil of platinum wire. The invention is not limited only to the use of copper wire, since nickel, silver, iron, emery, manganoxide, chrome-iron, and many other materials may be utilized for the purpose with good results.

A new electric headlight has been patented by Mr. John A. Mosher, of Chicago, Ill. This invention relates to that class of headlights used particularly on trolley cars, in which there is mounted both an arc and an incandescent lamp for alternate use; and the object of the invention is to provide for the automatic control of one lamp by the circuit of the other. Headlights of this character are of especial value in suburban and interurban service, for the reason that outside of the densely settled portions of a city there is usually very little artificial light provided along the line of railway, and hence a powerful headlight is essential to rapid transit. Within the city, however, a strong light is not only unnecessary, because the streets are usually well lighted, but it is objectionable, because of its glare and consequent risk of so confusing persons crossing the track as to cause instead of hinder accidents. This invention provides improved and simplified means for manually controlling the lamps, and it furthermore provides for bringing an incandescent lamp immediately into service automatically should any disarrangement of the arc lamp accidentally cut off its current. The arc lamp and incandescent lamp are located in the same casing, one being arranged above the other so that they will not interfere. Each lamp is provided with an independent circuit both of which are controlled by a common plug arranged in horizontal relation to the motorman and used only in the initial turning on of the current to the headlight and in finally cutting it out. In the circuit of the incandescent lamp is placed a spring switch arranged to be normally held in open position by an electromagnet forming a part of the circuit of the arc lamp. A simple circuit breaking switch of any desired form constitutes a part of the circuit of the arc lamp and is also located conveniently to the motorman. As long as this switch is closed the current will pass through the arc lamp and the electromagnet, thus holding the incandescent lamp circuit open. If, however, the switch is thrown to open position, or should the arc lamp become deranged, from any cause (a not improbable contingency in view of the constant and severe jarring to which the lamp is subjected) the electromagnet becoming deenergized will permit the closing of the spring switch of the incandescent lamp circuit, so that the lamp therein will be immediately and automatically lighted.



ELECTRIC HEADLIGHT.

The Western Electric Company, of Chicago, Ill., has purchased a patent recently granted to Mr. Charles E. Scribner, of Chicago, on a spring-jack for telephone switchboards. The invention concerns terminal spring-jacks or sockets, and consists in certain details of construction and disposition of parts for obtaining compactness of arrangement and cheapness of structure, at the same time affording secure contact between the terminal pieces in the spring-jack and corresponding portions of the plug. The improvement applies particularly to that class of spring-jacks which are mounted in groups on common bases or supporting plates, such as are usually known as "strips" of spring-jacks. In constructing the improved device, a strip or plate of insulating material is employed, through which transverse openings are drilled to receive the metal contact pieces of the jacks. One of these pieces is a short, tubular thimble, closely fitting the transverse opening and placed therein near one edge of the strip, its orifice being accessible near the front of the strip for testing purposes. From this contact piece an extension is led to the rear of the strip through a suitably inclined duct between adjacent perforations. Another of the contact pieces consists in a nearly annular spring located in the perforation at the rear of the thimble, already described, this spring being adapted to encircle and grasp the inserted plug. A metallic extension extends from this contact piece to the rear of the strip of spring-jacks. The third contact is a flat spring lying axially in the transverse perforation and tightly fitted therein at its rear extremity, the free extremity of the spring being used in the transverse opening to register with the tip of a plug inserted in the jack. The three contact portions of each spring-jack are thus located in a single drilled perforation in the strip, with their axes nearly concentric, and two ducts are provided for leading the terminals of two of the contact pieces to the rear of the strip, so that the operations essential in forming the strip of insulating material to receive the metallic parts of each jack, which operations ordinarily constitute the most costly processes in the construction of the spring-jack, consist merely in drilling the transverse opening and in forming two ducts extending therefrom for each spring-jack, together with a narrow slit opening into the perforation. One of the ducts may be a narrow channel cut by means of a saw; but with these exceptions the operations of forming the insulating base plate consist in drilling openings, the expensive processes of milling and drifting openings being wholly avoided.



SPRING-JACK FOR TELEPHONE SWITCHBOARDS.

Journal of the Western Society of Engineers.

The April issue of the *Journal of the Western Society of Engineers,* contains several interesting papers. Mr. Van Renssellaer Lansingh discusses the "Engineering of Illumination," and shows the use of moulding prismatic glass; Mr. Ernest Gonzenback describes the "Third Rail for High-Speed Electric Railway Service;" Mr. H. M. Brinckerhoff has an article upon "Electric Railways;" Mr. S. J. Larned, in a paper entitled "Telephone Service," discusses the chief value of telephone service in daily work; Mr. Ernest F. Smith describes the "Development, Equipment and Operation of the Substations," and "Distribution Systems" of the Chicago Edison Company, and the Commonwealth Electric Company, and Mr. George N. Eastman has an interesting paper upon the "Grounding of Alternate-Current Systems."

RADIUM.[1]

BY J. J. THOMSON.

The discovery by Monsieur and Madame Curie that a sample of radium gives out sufficient energy to melt half its weight of ice per hour has attracted attention to the question of the source from which the radium derives the energy necessary to maintain the radiation; this problem has been before us ever since the original discovery by Becquerel of the radiation from uranium. It has been suggested that the radium derives its energy from the air surrounding it, that the atoms of radium possess the faculty of abstracting the kinetic energy from the more rapidly moving air-molecules while they are able to retain their own energy when in collision with the slowly moving molecules of air. I can not see, however, that even the possession of this property would explain the behavior of radium; for imagine a portion of radium placed in a cavity in a block of ice; the ice around the radium gets melted; where does the energy for this come from? By the hypothesis, there is no change in the energy of the air-radium system in the cavity, for the energy gained by the radium is lost by the air, while heat can not flow into the cavity from outside, for the melted ice around the cavity is hotter than the ice surrounding it.

Another suggestion which has been made is that the air is traversed by a very penetrating kind of Becquerel radiation, and that it is the absorption of this radiation that gives the energy to the radium. We have direct evidence of the existence of such radiation, for McClennan and Burton have recently shown that the ionization of a gas inside a closed vessel is diminished by immersing the vessel in a large tank full of water, suggesting that part, at any rate, of the ionization of the gas is due to a radiation which could penetrate the walls of the vessel, but which was stopped to an appreciable extent by the water. To explain the heating effect observed with radium, the absorption of this radiation by radium must be on an altogether different scale from its absorption by other metals. As no direct experiments have been made on radium, it is possible that this may be the case; it is not, however, what we should expect from the experiments which have been made on the absorption of this radiation by other metals, for these experiments have shown that the absorption depends solely upon the density of the absorbing substance, and not upon its chemical nature or physical state; if this law holds for radium, the absorption by it would be on the same scale as the absorption by lead or gold, and altogether too small to explain the observed effects. We are thus led to seek for some other explanation. I think that the absence of change in the radium has been assumed without sufficient justification; all that the experiments justify us in concluding is that the rate of change is not sufficiently rapid to be appreciable in a few months. There is, on the other hand, very strong evidence that the substances actually engaged in emitting these radiations can only keep up the process for a short time; then they die out, and the subsequent radiation is due to a different set of radiators. Take, for example, Becquerel's experiment when he precipitated barium from a radio-active solution containing uranium, and found that the radio-activity was transferred to the precipitate, the solution not being radio-active; after a time, however, the radio-active precipitate lost its radio-activity, while the solution of uranium regained its original vigor. The same thing is very strikingly shown by the remarkable and suggestive experiments made by Rutherford and Soddy on thorium; they separated ordinary radio-active thoria into two parts, transferring practically all the radio-activity to a body called by them thorium X, the mass of which was infinitesimal in comparison with that of the original thoria; the thorium X thus separated lost in a few days its radio-activity, while the original thoria in the same time again became radio-active. This seems as clear a proof as we could wish for that the radio-activity of a given set of molecules is not permanent. The same want of permanence is shown by the radio-active emanations from thorium and radium, and by the induced radio-activity exhibited by bodies which have been negatively electrified and exposed to these emanations or to the open air; in all these cases the radio-activity ceases after a few days. I have recently found that the water from deep wells in Cambridge contains a radio-active gas, and that this gas, after being liberated from the water, gradually loses its radio-activity; the radio-activity of polonium, too, is known not to be permanent.

The view that seems to me to be suggested by these results is that the atom of radium is not stable under all conditions, and that among the large number of atoms contained in any specimen of radium, there are a few which are in the condition in which stability ceases, and which pass into some other configuration, giving out as they do a large quantity of energy. I may, perhaps, make my meaning clearer by considering a hypothetical case. Suppose that the atoms of a gas X become unstable when they possess an amount of kinetic energy 100 times, say, the average kinetic energy of the atoms at the temperature of the room. There would, according to the Maxwell-Boltzmann law of distribution, always be a few atoms in the gas possessing this amount of kinetic energy; these would by hypothesis break up; if in doing so they gave out a large amount of energy in the form of Becquerel radiation, the gas would be radio-active, and would continue to be so until all its atoms had passed through the phase in which they possessed enough energy to make them unstable; if this energy were 100 times the average energy it would probably take hundreds of thousands of years before the radio-activity of the gas was sensibly diminished. Now in the case of radium, just as in the gas, the atoms are not all in identical physical circumstances, and if there is any law of distribution like the Maxwell-Boltzmann law, there will, on the above hypothesis, be a very slow transformation of the atoms accompanied by a liberation of energy. In the hypothetical case we have taken the possession of a certain amount of kinetic energy as the criterion for instability; the argument will apply if any other test is taken.

It may be objected to this explanation that if the rate at which the atoms are being transformed is very slow, the energy liberated by the transformation of a given number of atoms must be very much greater than that set free when the same number of atoms are concerned in any known chemical combination. It must be remembered, however, that the changes contemplated on this hypothesis are of a different kind from those occurring in ordinary chemical combination. The changes we are considering are changes in the configuration of the atom, and it is possible that changes of this kind may be accompanied by the liberation of very large quantities of energy. Thus, taking the atomic weight of radium as 225, if the mass of the atom of radium were due to the presence in it of a large number of corpuscles, each carrying the charge of 3.4×10^{-10} electrostatic units of negative electricity, and if this charge of negative electricity were associated with an equal charge of positive, so as to make the atom electrically neutral, then if these positive and negative charges

[1] Reprinted from *Nature*, London, April 30.

were separated by a distance of 10^{-8} centimetres, the intrinsic energy possessed by the atom would be so great that a diminution of it by one per cent would be able to maintain the radiation from radium as measured by Curie for 30,000 years.

Another point to be noted is that the radiation from a concentrated mass of radium may possibly be very much greater than that from the same mass when disseminated through a large volume of pitch blende; for it is possible that the radiation from one atom may tend to put the surrounding atoms in the unstable state; if this were so, more atoms would in a given time pass from the one state to the other if they were placed so as to receive the radiation from their neighbors than if they were disseminated through a matrix which shielded each radium atom from the radiation given out by its neighbors.

THREE GOOD TELEGRAPH STORIES.

BY WALTER P. PHILLIPS.

I was on my way to report the National Democratic Convention at Chicago (1884) and stopped over in Buffalo as the guest of Mr. Edward H. Butler, proprietor of the *Evening News*. In the course of the morning Mr. Butler said: "Governor Cleveland came up from Albany last night to spend Sunday in Buffalo, and if you would like to meet him we will go around to his law office and have a chat with him." We had hardly arrived when it began to rain, and a succession of summer showers detained us for an hour or more. When we finally arose to go, Mr. Cleveland said: "Mr. Phillips, you must not print this, but I will say it for your guidance when you reach Chicago. It may assist you, as things are likely to happen out there that will influence your judgment. As the governor of this state I believe I have done some good; whether or not if elected president of the United States I should succeed is a question that only time could determine. Even if nominated, I might not be elected—that of course is problematical, but as far as the nomination is concerned I shall receive that. You can depend on what I say."

A few days later we were endeavoring to report one of the most tumultuous conventions that was ever held. Mr. Grady, of New York, made a speech against Mr. Cleveland that threw the convention into an uproar and there were cries and shouts everywhere, and the name of Hendricks was the watchword. Pandemonium reigned for twenty minutes and the reporters were idle and anxious. It was impossible for any one to make his neighbor hear a word, and one of the United Press men, catching my eye, telegraphed with his own eyes by closing and opening his eyelids. "Shall we bulletin that Hendricks will be nominated by acclamation? That is what some of the fellows are sending off." Not being able to telegraph with my eyes, I rapped out in reply by striking one hand on the other, "No, we will stick to Cleveland." As all operators know, the telegraphic characters can be easily read by sight, although the usual way of reading them is by sound. I had been through a trying experience at the Republican National Convention a little earlier, and I was so upset by what was occurring that I left the hall and went out for a breath of fresh air, and then over to the Palmer House. I was worried, but the impressive words of Mr. Cleveland kept ringing in my ears. The colored man who threw open the half-doors at the side entrance of the Palmer House, greeted me with the words: "Governor Cleveland's nominated." His face was wreathed in smiles and I fairly laughed for joy. It was a great relief when one is making predictions to have them come right. The reputation a newspaper writer has worked years to secure may be swept away in ten seconds if he makes one big mistake.

The other trying experience was in connection with the nomination of Mr. Blaine. Mr. P. V. De Graw was practically in charge of the work of reporting that convention, and I may say right here that in my judgment he is the most capable press association manager that has ever lived. The Louisiana Purchase Fair has my sincere congratulations on having secured his services in connection with its press work during the coming year. Although Mr. De Graw was omnipresent, and I was but an onlooker in Vienna, as his superior officer I had the right to get into mischief if I desired. I overheard a telegram from Senator Cullom going to General Logan, at Washington, saying it seemed impossible to nominate either him or Blaine and asking if General Logan would accept second place on the ticket with Blaine. The answer quickly came back and I happened to be where I could hear that also. So I kept Senator Cullom in sight and when he was handed the telegram he withdrew from the convention hall and was quickly joined by a few of his associates. As I approached the group and spoke to Colonel Ingersoll, who was lighting a cigar, Senator Cullom asked, in a general way, if the present ballot should be stopped, "or," he said, "now that Logan says he will do whatever we wish, shall we nominate Blaine on the next ballot?" Colonel Ingersoll quickly replied: "Next ballot, by all means. I want to finish my smoke." It was my first national convention, and in my innocence I wrote a bulletin saying: "Blaine is nominated." Then I sent word to De Graw as to what I had done and he looked very grave. I was not quite easy in my own mind for the next fifteen minutes, but when the next ballot was taken and Alabama broke for Blaine, and the other states followed that lead, all my associates rose up an called me blessed. The United Press was a new concern, reorganized that very year, and our premature announcement of the nomination of Blaine was a shock to the newspapers of the whole country. If it had been wrong, it would have killed us. But a great deal is forgiven to the successful, and from that day our star was in the ascendant.

My relations with Mr. Blaine had been very close and cordial during the preceding four years that I had been manager of the Associated Press at Washington, and I had gone to Chicago very much in love with the man, confident of his nomination and sanguine of his election. To the end of standing well with his prospective administration, and with a view to bringing my opposition press association forcibly to his attention, I conceived a plan of notifying him of his nomination that would probably enable me to beat the Associated Press. I filed by the Western Union Telegraph Company, at Chicago, New York and Boston, a telegram addressed to Mr. Blaine at Augusta, Me., with instructions to release it for transmission whenever it was learned from any source whatsoever that he had been nominated. As it turned out it was my own bulletin that released the three messages. I afterward asked Mr. Blaine's secretary if they heard from me ahead of the others and he answered that they received three messages in a bunch by the same messenger fully half an hour before my news was confirmed, and he quoted Mr. Blaine as saying: "Walter Phillips seems to be in three places at once—Chicago, New York and Boston. The situation reminds me of the story of the Frenchman who was panic-stricken at the apparent prospect of Laura Keene's dismemberment when he read on a theatrical poster that she was to appear in three pieces."

Reviews of Current Engineering and Scientific Literature.

Frequency Regulation.

The importance of the problem of satisfactory regulation of alternators coupled in parallel is discussed in this article by M. C. F. Guilbert. The frequency given by an alternator depends upon the speed of the prime mover which is usually controlled by a centrifugal governor. The author believes that an electrical control would be preferable and outlines several methods of securing this. The first improvement suggested is to drive the governor by a synchronous or induction motor connected to the alternator rather than by the prime mover itself. This governor should act upon the speed governor of the engine or upon the controlling valves of the turbine, and would maintain a constant speed independent of the load. Another method suggested is to mount on the shaft of a shunt motor which is driven by some means, at a constant speed, the armature of a small alternating-current generator. The field of this generator is to be supplied by polyphase currents drawn from the line to be controlled. These currents will set up a rotating field which will revolve in the same direction as the armature. If the frequency of the circuit varies, the rotary field will revolve either more rapidly or more slowly than the constant speed armature. The result will be to set up in the latter polyphase currents which can be used to operate the controlling mechanism of the prime mover so as to correct any change of speed which may occur.—*Translated and abstracted from La Revue Technique (Paris), April 26.*

Effect of the Shape of the Wave Form on Transformers.

In this article Herr S. Hahn considers the effect of the wave form of the alternating current on transformers. The subject is first considered theoretically and equations are given for the effective values of electromotive force and current when the wave form is triangular and trapezoidal. In general, these curves are only approximated, the straight line sides being replaced by slightly curved lines. The case is then considered of a transformer which has been calculated for the sine curve, but which is connected to circuits in which the wave form is either of the two cases considered above. Through the decrease in the induction, the hysteresis and eddy current losses are decreased. The latter, however, decreases but slightly, but there is some decrease in the Joule loss. The author has found by experiments that these decreased losses allow the transformer to operate at a temperature from eight to thirteen degrees centigrade less than when used on a circuit having a sine wave. He gives a table in which the losses in watts for hysteresis and eddy currents have been computed for varying values of the induction and for the three types of waves considered, and for two frequencies, 50 and 100 cycles. These values are also shown graphically. For fifty cycles the curves are approximately straight lines, so that it is possible to deduce a coefficient by which the losses may be easily computed. The practical value of this method is discussed and applied in a specific case. The computation shows that the efficiency of the transformer which was 95.2 per cent with a sine wave rises to 96.8 for a triangular wave and to 96.6 for the trapezoidal.—*Translated and abstracted from Elecktrotechnischer Anzeiger (Berlin), April 19.*

The Testing of Alternate Current Switches and Fuses.

It is recognized that the severity of a test on the circuit-breaking capabilities of a switch or fuse is not only dependent on the current and voltage but on the power-factor of the current broken. The influence of the latter is here discussed by Mr. G. W. Howe. Normally, a switch or fuse is in series with a resistance and an inductance, across terminals at which a constant potential is maintained. Upon opening the switch, the resistance of the arc is introduced, this resistance varying from zero to infinity. For a certain value of this resistance there is a maximum power in the arc and an expression for this is deduced by the author. An equation is also given for the ratio of the maximum power in the arc to the power in the circuit before breaking. Applying these equations to a specific case in which a current of 100 amperes is assumed to be flowing at a constant voltage of 1,000, if the power-factor of the circuit is unity, the maximum power in the arc is twenty-five kilowatts. If the power-factor has the value 0.1, the maximum power in the arc is 45.5 kilowatts. For a given current the test is more severe if the current lags, and a convenient method of testing switches and fuses is to put them in circuit with a number of choking coils which, by means of variable air-gaps and alternative connections, allow of a wide range of currents and voltages. The power-factor under these conditions is low, making the test more severe.—*Abstracted from the Electrical Review (London), May 1.*

Researches on Splitting up Alternating Currents.

Means of obtaining unidirectional currents from alternating currents are not only interesting scientifically, but may have much practical value. Herr G. Benischke describes in this short article some interesting experiments which he has made in order to accomplish this result. The first work was carried out with an alternating-current arc, one of the carbons of which was replaced by two independent carbons insulated from each other by mica. Each of these was connected in circuit with a movable coil ammeter. Beyond the ammeters the two circuits were connected together and after passing through a dynamometer this line was connected to one side of the alternating-current circuit. One pole of a continuous-current electromagnet was placed directly behind the arc, and when the current was passed through the arc this was split up into two unidirectional currents, one flowing through each carbon of the double electrode. When the two carbons are of different quality, the two derived currents are not equal. This method, however, is not a practical way of producing unidirectional currents, because the loss of potential in the arc is from forty to fifty volts. Attempts were made to obtain a more efficient method by substituting for an arc a sheet of metal, one side of which is connected to one line of an alternating circuit and to the corners of the other side two lines which run to the other side of the circuit. Bringing an electromagnet up to the plate produced no effect whatever. In the same way an electrolytic cell was experimented with, but without results, nor did a mercury vapor arc fitted with three electrodes act. These experiments are interesting as bringing out the difference in the kind of conduction which takes place in arc lights, electrolytic cells,

metallic conductors, or the mercury vapor arc.—*Translated and abstracted from Physikalische Zeitschrift (Leipzig), May* 1.

Electric Lighting of Railway Cars.

In this section of a serial article Mr. R. Goetze discusses the use of accumulators for train lighting. Two systems are considered; that in which the entire train is lighted from one or more sets of batteries installed on one or two cars, and that in which each car has its individual equipment. The first system is in use on the Danish state railways and the second has been applied to the Royal German mail cars. The Danish trains are lighted from two sets of accumulators, each set consisting of two independent batteries. One set is placed upon the leading car and the other on the rear car of each train. Two complete circuits are carried throughout the train and there are two lamps in each compartment, one being attached to each circuit. By this arrangement one lamp will always be lighted in every compartment as long as that car is connected to either end of the train. Each battery consists of thirty-six elements, with a capacity of 130 ampere-hours at a discharge rate of six amperes. The two batteries operate in parallel. Each element consists of six positive and six negative plates placed in hard rubber jars covered with glass. Four such elements are mounted in a wooden box, which is placed under the car in suitable compartments and which are automatically connected in circuit. The weight of each of these four elements is eighty-five kilogrammes, so that the car contains a double battery weighing about 1.5 metric tons. Two eight-candle-power lamps are placed in each first and second-class compartment, and two five-candle-power lamps in each third-class compartment. The batteries are charged when the train is standing at the depot, and, as the running time of the train is short, this system has been satisfactory. Resistance is used, regulated by hand, to maintain the proper voltage at the lamps. The German mail cars are of two sizes. The large car, twelve metres long, contains two batteries of sixteen cells each, and the shorter combination mail and baggage car contains one battery of sixteen cells. Each battery consists of four boxes containing four cells, with a capacity for the battery of 120 ampere-hours. Each element contains, in the older type, four positive and five negative plates, and in the newer type, three positive and four negative plates. These plates are mounted in celluloid jars. The weight of a battery of sixteen cells is 184 kilogrammes for the older type, and 172 kilogrammes for the new type. The cars are lighted by means of seven twelve-candle-power Sirius lamps. The batteries may be charged while the car is standing at the depot or they may be exchanged for fresh batteries. When charging, the arrangements are such that the more fully discharged cells receive a longer charge. There are at the present time 1,500 mail cars equipped in this way.—*Translated and abstracted from the Centralblatt für Accumulatorenkunde (Berlin), May* 1.

Protection and Preservation of Wood.

Methods of preserving wood have received much attention from engineers, and the method here described by Mr. Joseph L. Ferrell will doubtless prove of interest. Attempts to preserve wood have been made from the earliest times, both to protect it from decay and against fire. The plan followed in all cases has been to extract, as far as possible, the sap contained in the wood, and to replace it by some chemical which would either resist decay or the action of heat. These methods have been too expensive for the slight protection obtained. These processes consist of three stages, and require from twenty-four to thirty hours. The newer process here described reduces the time and the expense by doing away with the first stages. The apparatus consists of a cylindrical body, fifty inches in diameter and 112 feet long. It is made up of cast-steel flanged sections, with hydraulic joints, and capable of enduring a pressure of 1,000 pounds per square inch. At each end is a domed gate with a vertical hydraulic cylinder. This gate closes from the inside, so that the greater the pressure the tighter the joint. Pressures vary from 300 to 650 pounds, according to the kind of wood used. The wood is taken as it comes from the source of supply, put into the cylinder without removing the sap, pressure is applied, and the lumber is then run into the dry kiln. For treating railway ties a special machine has been developed, similar to that described above, but having a gate at but one end. At the other end is a heavy cast-iron pad, inlaid with a heavy rubber ring. The tie is introduced into this cylinder, which is but slightly longer than the tie. The gate is constructed similarly to the pad, and has an opening within the rubber ring. When this is closed, the pad is moved up against the other end of the tie by means of a rod, and the preserving solution forced through the tie by hydraulic pressure. This pushes out the sap at the other end, where it flows out through an opening in the gate. After all the sap has been forced out, the openings in the gate and pad are closed, and a second solution which will react chemically with the first is forced into the tie from the sides. Thus, by pumping sulphate of zinc in at the ends, and chloride of lime from the sides, sulphate of calcium is deposited within the wood, penning in the chloride of zinc formed. To protect wood against fire, the material is treated in about the same way, but the solution used is sulphate of aluminum. This, under action of heat, is reduced to alumina, which is a good non-conductor. Another process has been developed for treating wood which has already been used in buildings. This material is applied in two parts. The first soaks deeply into the wood, and applying the second, this reacts chemically with the first, forming a hard, transparent enamel, in no way injuring the color or texture of the wood.—*Abstracted from the Proceedings of the Engineers' Club, of Philadelphia, April,* 1903.

Electrolytic Synthesis of Sugars.

This article reviews the work done by Julius Walther, of St. Petersburg, in which Mr. Walther showed that starting with carbolic acid, generated from marble and hydrochloric acid, he could obtain a synthesis of organic compounds by electrolytic action. It was found that the current density was of great importance, and the anodes used consisted of brushes of platinum wire. The cathodes had a large surface and were made of platinum, silver, mercury, or other metal, or of clay. A clay pot was used as a diaphragm, and the anode solution was kept about five degrees centigrade above that of the cathode solution. Electrolysis commenced when the water was saturated with carbolic acid with a difference of potential of two volts. By raising the voltage and the strength of the current, either by heating the electrolyte or increasing the cathode surface, oxalic acid made its appearance, the current being about 0.75 ampere. Next tartaric acid was formed the voltage being four, and then citric acid. When the voltage reached five, carbohydrates appeared, fruit sugar first, finally grape sugar. Some of the sugars reduce Fehlings solution and are capable of direct fermentation. Walther regards the phenomenon essentially as oxidation and reduction processes. The article then goes on to discuss the obliteration of the dividing line between organic and inorganic chemistry, and that between animate and inanimate substances.—*Abstracted from Engineering (London), May* 1.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Automatic Signal System for Electric Railways.

The Pneumatic Signal Company, New York city, has purchased from Mr. S. Marsh Young, owner of the "Young system" of automatic electric track circuit block signals for electric railways, all his rights for the United States, Canada and Mexico, and will arrange to place the system at once on the market.

The "Young system" furnishes the same measure of protection for electric lines as the standard track circuit system does on steam roads. The presence of any pair of wheels on the block section, a broken rail or wire, or an open switch results in a danger signal.

The Signal Company will organize an electric railway department, which will be in charge of Mr. Young. It will be remembered that Mr. Young was one of the incorporators and the first vice-president of the Hall Signal Company, and was for some years the vice-president and general manager of the Manhattan General Construction Company, until he sold the company to the Westinghouse interests.

The Pneumatic Signal Company's factory has been until recently at Troy, but it is now moving into its new works at Rochester, N. Y. This plant will cover about two hundred and forty thousand square feet of floor space, and will be one of the largest and most complete plants of its kind in the world.

The system by which this company is best known is its low-pressure pneumatic system for interlocking and block signals on steam railway lines, and is used most extensively in both Europe and America. Its entering the street railway field is a new departure, and it is its intention to bring all its experience in the field of steam railway signaling to bear upon the several problems which are confronting the management of high-speed electric lines.

New Western Supply Company Opening.

The Ewing-Merkle Electric Company, of St. Louis, Mo., formally opened its new store at 1106 Pine street, on Saturday, April 25. A number of representatives of electrical companies and allied interests were in attendance, and manifested much pleasure in inspecting the new quarters.

On the first floor, directly opposite the entrance, are placed specially designed show-cases in the form of a square, in which are contained samples of nearly all the small material needed in the lighting and telephone industries. Beyond the city counter, which is served by a dumb-waiter connecting with the seven floors, is the exhibit room, in which are located motors, dynamos, arc lamps, switchboards, electric fans, telephone and electric fixtures, and the larger articles used by contractors, electric light and telephone companies. This floor is divided about midway by a glass partition, behind which

SHOW ROOM, FIRST FLOOR, EWING-MERKLE ELECTRIC COMPANY, ST. LOUIS, MO.

are located the shipping and receiving departments.

The basement, which is an especially large and airy one, is used to store Roebling's telephone wire, cross-arms, glass insulators and iron conduit, arranged in a convenient and accessible manner.

The main or general offices of the company are on the second floor. These offices are fitted up in a handsome manner, finished in golden oak, and so arranged as to afford great convenience for the transaction of business. On this floor are placed the private branch telephone exchange and telegraph instruments.

The third floor is given up to the lighting supplies, the arrangement of the shelving being such that the greatest amount of space is obtained, and the fourth floor contains all the copper wire —rubber-covered, weather-proof, magnet, annunciator and cable—the stock of which is very complete. On this floor the shelving for the glass shades, reflectors and incandescent lamps is placed.

On the fifth floor are placed all the standard packages—that is, goods that are never unpacked—carloads of electric fans, arc lamps, sockets, cutouts, carbons, knobs, porcelain tubes, incandescent lamps, transformers, speaking tubes; and on the sixth floor are the brackets, pins, construction tools and wood mouldings.

The company makes use of a perpetual inventory, which enables it to answer telephone and telegraph enquiries instantly as to stock.

New Type Rheostat.

The accompanying illustrations show the new form of rheostat designed by Charles Wirt, of Philadelphia, Pa., and for which the Scott award was made by the Franklin Institute of Pennsylvania. In view of this award and the peculiar construction of the apparatus, a description of this instrument will doubtless be of general interest. Referring to the illustrations, Fig. 1 shows the assembled rheostat, and Fig. 2 gives a sectional view of the interior proportions. The resistance proper, H (Fig. 2), is formed from a single piece of resistance tape, wound without break or joint into the necessary number of steps—never less than fifty.

This ensures at all times an unbroken circuit from one end to the other. Moreover, this is accomplished while still securing a desired taper or graduation to each individual step, and securing this feature without the necessity of a twisted joint or a possible chance for open circuit.

RHEOSTAT ASSEMBLED.

An important point in the construction of this rheostat is the intimacy and certainty of contact of each resistance step with its corresponding commutator bar. Each commutator bar, E, has contact for its full length and width with its resistance coil, H. Contact is ensured by being made under heavy pressure.

The varying widths of the commutator bars, E, increasing progressively in width in accordance with the increasing current capacity at each point, ensures an area of contact with the switch, C, at every point, proportional to the current carried.

The insulation throughout is of mica, and this material is capable of withstanding excessive heating and sudden temperature changes.

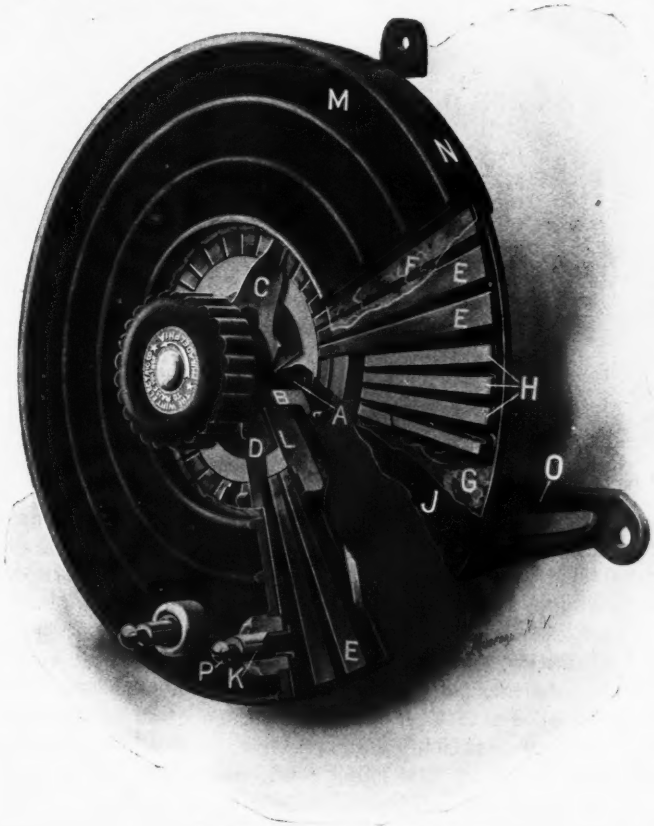
A porcelain knob is supplied on the front of the board type of apparatus, instead of a wooden knob, as this has been found less liable to crack. The terminal posts are heavy and substantially swedged, making a solid connection for the wires. The switch is made of spring phosphor-bronze, and makes connection with the centre of the ring and the commutator section upon which it is placed. This avoids passing current through the bearings. The switch and its accompanying switch centre are carefully insulated with mica from the shaft.

The rheostat shaft runs in a babbitt metal bearing of ample length, and is of such construction as to ensure positive contact at every point.

The hand-wheel furnished on the back of board rheostats is finished in copper, as are also the face-plate, attaching screws, bonnet nuts, etc. The hand-wheel is prevented from turning on the shaft by means of hardened steel-pointed set screws.

To insulate the resistance coils, mica is used exclusively, and to insulate the resistance and commutator bars from the containing case, mica discs are employed. The resistance coils, with their accompanying commutator bars and mica discs, are placed between two metal plates, the back one of pressed steel, the front one of cast iron. These plates are held firmly together by means of a steel band spun over the edge. By this construction the resistance ribbon lies flat against the radiating plates, the only intervening substance being a thin sheet of insulating mica. This permits the heat to be most readily conducted to the external surface, and then dissipated. The result is that the resistance material always runs cool, enabling each plate to work at its greatest efficiency.

These rheostats are manufactured by the Wirt Electric Company, Philadelphia, Pa.



RHEOSTAT, SHOWING ASSEMBLING.

Trackless Trolley.

An electrically propelled omnibus drawing current from two trolley wires and running upon the original highway is to be tried in the Stroud district of Gloucestershire, England. This district is said to be peculiarly fitted for a service of this kind, which will save the expense of a right of way and track.

Water Power in New Zealand.

Mr. Allo, a Swiss engineer, visited recently Huke Falls in the North Island of New Zealand, and examined the falls. He estimates that taking the water at the lowest stage, at least 39,000 horse-power may be obtained. It is suggested that this power be developed and distributed into four quarters of the island. The power would be sufficient to operate all the North Island railways electrically and is more than double that necessary to operate all the steam railways of this section. It is further estimated that a saving of thirty-three per cent in the cost of power will be made by developing these falls.

A Novel Use for Underground Electrical Conduits.

That underground electrical conduit may be made to do good service in fields other than that for which it was designed is proven by the application which the Rockland Light and Power Company, of Nyack, N. Y., has recently made of a peculiar form of underground conduit. This company, having occasion to lay a line of steam pipe underground for a considerable distance to supply one of its power customers with steam for manufacturing purposes, experienced an unusual difficulty owing to the formation of the ground through which the pipe was laid, which caused excessive condensation

PIPE LINE LAID IN UNDERGROUND CONDUITS.

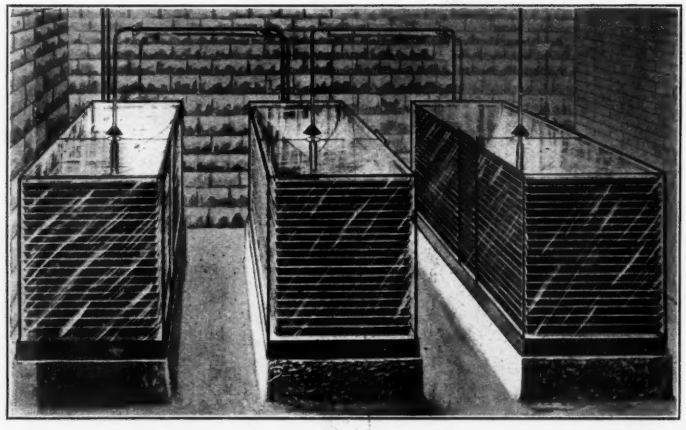
in the pipe line, and also very rapidly deteriorated the line and line covering. The steam was to be conveyed at about 100 pounds pressure the year round. Various combinations of material had failed to give satisfaction, because of the above-mentioned conditions, and the pipe line was finally installed with the "Diamond S" brand of pipe, manufactured by the John Simmons Company, this pipe being covered with standard eighty-five per cent magnesia covering, made by the H. W. Johns-Manville Company, New York city. This wrapping, in turn, was covered with standard "screw coupling" pipe, manufactured by the Fibre Conduit Company, of Orangeburgh, N. Y. This conduit, being water-tight and not corroded or injured by moisture, keeps the magnesia covering and the surface of the iron pipe dry at all times, and by reason of its own heat-insulating qualities, is stated to add greatly to the effect produced by the magnesia covering. The company announces that the pipe, laid two feet underground, is operating in winter and summer with no appreciable condensation.

A New Tray Storage Battery Equipment.

A novel form of storage battery, for which a number of important claims are made, has been installed for the light, heat and power service in the new Hotel Carlton, Boston, Mass. This is the largest battery of the new tray type manufactured by the Smith Storage Battery Company, Binghamton, N. Y., and which has been described recently in the ELECTRICAL REVIEW. The battery consists of fifty-seven trays, fifty-six of which are used. The battery room is ten by eighteen feet in size. The trays are each three by seven feet in size, and are nested in three piles about four feet high. This permits of comfortable passageways around the piles, and of a compactness of installation that means a great deal to a person having to save all possible floor space.

The rated capacity of the battery is 800 ampere-hours, the normal discharge rate being 100 amperes. The peculiar construction of this battery is stated to enable it to promptly respond to almost any overload which may be placed upon it. The battery is used to equalize the load for all the lighting and power plant of the hotel, with electric heating used in many ways. For seven hours out of each twenty-four it performs the entire service. From six o'clock in the morning until eleven at night it is continually charging and discharging at a constantly fluctuating rate. The remainder of the time the generator is shut down. It is also stated that the drop in electromotive force from midnight until morning never exceeds one volt. Because of the varying demands of service, the battery has to respond to frequent sudden changes of load. Sometimes the discharge exceeds 400 amperes, or over four times the normal rate. During the day the discharge is frequently 300 amperes or more, lasting but a short time, the load dropping off suddenly, immediately followed by charging current up to 100 amperes.

This ability to respond to excessive loads, the manufacturer states, results from the features which make this battery unique. These features are its shape, method of gridding and processing, the short space through the electrolyte between the positive side of one tray and the negative side of the next, and the absence of connecting jumpers between the plates and numerous terminals. These features give the battery a low internal resistance.



TRAY PLATE STORAGE BATTERY INSTALLATION.

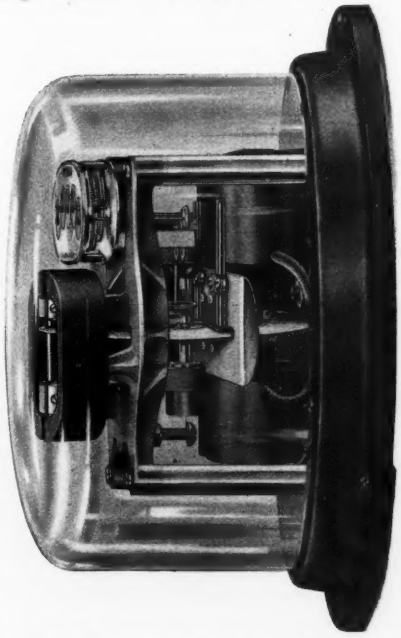
The accompanying illustration shows the equipment in the Hotel Carlton.

The Centennial of Justus Liebig's Birthday.

A notable meeting of chemists was held at the Chemists' Club, New York city, Tuesday evening, May 12, to celebrate the centennial of Justus Liebig's birthday. Addresses were made by Dr. Ira Remsen, president of Johns Hopkins University, Professor William H. Brewer, of Yale University, and Dr. C. Duisberg, vice-president of the Verein Duetscher Chemiker. Dr. Remsen and Professor Brewer both studied under the famous chemist and gave interesting reminiscences of Liebig and their work with him. Dr. Duisberg spoke of Liebig's relation to the chemical industry, of the changes brought about, and of the present conditions.

Glass-Enclosed Switchboard Meters.

The Stanley Instrument Company, Great Barrington, Mass., is placing on the market a type of switchboard meter which is especially adapted for mounting on office switchboards. As may be seen from the accompanying illustration, the meter is entirely enclosed in glass, so that its workings may be at all times in view of the customer, and, as seriously suggested in the company's literature, this apparatus will be found to be an attractive object lesson to the customer of any company, through seeing it in actual operation, showing the method by which the current is registered and the accuracy of registration. It also provides a means of



GLASS-ENCLOSED SWITCHBOARD METER.

demonstrating to customers that the rate of registration is directly proportional to the rate of use of current, and that the meter registers only when current is used.

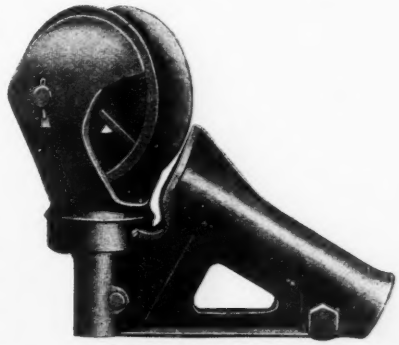
The mechanical and electrical design of the meter is of the well-known type of magnetic suspension recording meter, manufactured by the Stanley company. The magnetic suspension elements consist of a permanent magnet and steel plugs or pole-bushings. The rotating parts, floated in air, are the aluminum disc and the soft steel vertical shaft, called the suspension core, to which the disc is rigidly secured. The lower end of the suspension core is flanged larger, while the upper end is turned smaller in diameter than the body of the core. The flanged lower end of the suspension core is in a cup formed in the lower pole-bushing. The upper end of the suspension core, when in magnetic suspension, is just inside of a recess on the upper pole-bushing. The difference in diameters between the flange of the suspension core and the cup in the lower pole-bushing, as also between the upper end of the suspension core and the recess in the upper pole-bushing, is such that there is a predetermined space all around the flange in the lower pole-bushing, and all around the upper end of the core in the upper pole-bushing. When the suspension magnet is not in place, the flanged end of the suspension core, due to gravitation, will naturally rest on the surface of the cup in the lower pole-bushing; but due to the difference in diameters, it will not touch upon the circumference of the cup at any point, there being an air space between the periphery of the flange and the circumference of the cup. When the suspension magnet is not in place, and when the lower end of the suspension core rests on the surface of the cup in the lower pole-bushing, the upper end of the core will be slightly below the lower edge of the upper pole-bushing. The magnetism passes between the ends of the magnetized plugs in the upper and lower pole-bushings, and attracts the steel suspension core with the disc attached in an upward direction, lifting the flanged lower end of the suspension core from contact with the surface of the cup in the lower pole-bushing, and carries the upper end of the suspension core into the recess in the upper pole-bushing. By the laws of magnetism, the magnetic field into which the suspension core, with its attached disc, is thus attracted, acts uniformly upon the suspension core, holding the rotating parts in a predetermined, definite position in space, free from mechanical support or contact of any kind. The disc is guided by a fine piano wire axis, there being no mechanical rubbing contact of any kind.

A Rivet Coupling.

The need has been felt for a coupling to unite electric wires which would not necessitate the use of solder. When soldered joints are made, some substance must be used to clean the wire, so that the solder may take hold, and this material is often an acid or a salt containing a trace of acid, the presence of which within the joint causes corrosion and impairs the electrical contact. To avoid the use of acid, a neat coupling has been brought out in Germany, known as the "Nietverbinder." The coupling is a flattened sleeve of pure copper, pierced by two openings. To make a splice, the proper size of sleeve is selected, and the ends of the two wires are slipped into this, just filling up the sleeve. Then the two wires are forced apart by means of a punch and anvil, the former being driven through the two openings. This is then withdrawn, and two rivets inserted in the holes and riveted up. The result is a good electrical and mechanical joint which is easily made. This coupling is manufactured by J. W. Hofmann, Kalzschenbroda, Dresden.

A Swivelling Trolley.

The accompanying illustration shows a type of trolley-wheel which has been introduced to some extent in England. As will be seen, the wheel swivels on a vertical pinion, allowing it to follow the wire through considerable lateral variation.



SWIVELLING TROLLEY.

This allows the erection of trolley wires over the side of the track, shortening the brackets, with centre-pole construction, and also permits side bracket construction to be used with the track some distance from the side of the road.

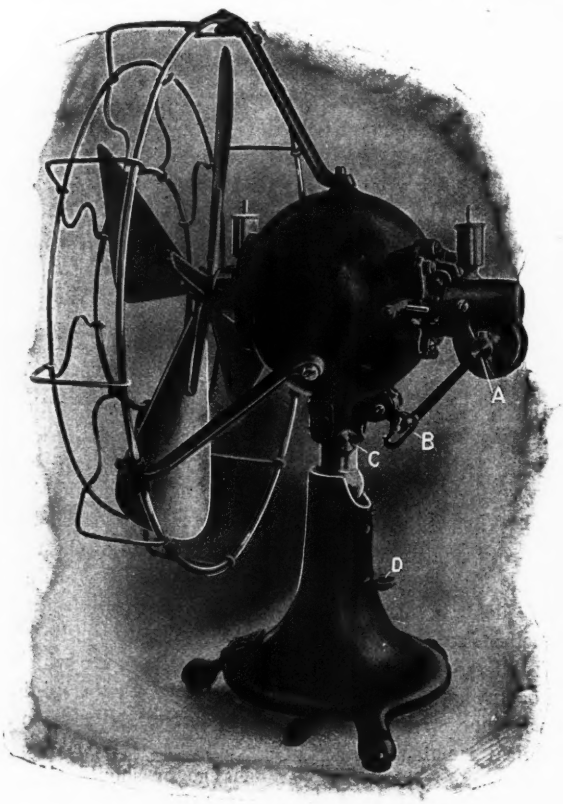
The wheel is made from a specially tough mixture, has a long life and is fitted with a graphite bushing. It is held in a vertical harp which is maintained in this position by a pinion and rests on a ball-bearing. The harp can be slipped off easily when it is necessary to make a change or should the wheel become entangled in the wires. This wheel is made by Messrs. W. E. Rowlands & Company, Birkenhead, England.

New General Electric Directors.

At the annual meeting of the stockholders of the General Electric Company, at Schenectady, May 12, the number of directors was increased from thirteen to fifteen. The new directors chosen were ex-Governor W. M. Crane, of Massachusetts, and Hon. W. C. Whitney, of New York. The following were reelected directors: Gordon Abbott, Oliver Ames, C. A. Coffin, T. Jefferson Coolidge, Jr., Frederick P. Fish, George P. Gardner, Eugene Griffin, Henry L. Higginson, J. Pierpont Morgan, J. P. Ord, Robert Treat Paine, 2d; George Foster Peabody and Charles Steele.

A New Model "Universal" Fan.

The Eck Dynamo and Motor Works, Belleville, N. J., is introducing to the market a new type of electric fan which is designated as the "Universal." This fan possesses primarily all of the features which have made the company's "Hurricane" fan popular for a number of years past, with the addition of auxiliary devices which adapt it to be used either as a desk, bracket, trunnion or bracket-trunnion fan, with an oscillating attachment in each case. The fan, as now constructed, can be adjusted for any of the different types, and will operate at any angle and at any speed. There is no



Universal Fan.

leveling and no delicate adjusting necessary. The accompanying illustration will make clear the operation and adjustment of the new attachments. To adjust the fan from a desk to an oscillating fan, the screw, A, is loosened, and the connecting rod is lifted at B. The screw, A, is moved from the centre of the wheel and tightened. The further the screw is moved from the centre, the greater is the arc of oscillation, and *vice versa*. In order that the fan may have a full range of rotation, the screw, C, is loosened. To adjust from an oscillating to a desk fan, the screw, A, is loosened and moved toward the centre of the wheel until it stops, and the screw is then tightened. The screw, C, is then tightened, which makes a positive adjustment of the motor body on the vertical shaft. To adjust to a trunnion or bracket fan, the screw, D, is loosened, and the head of the motor set at any angle desired, and the screw, D, then tightened. The connecting rod, at B, is lifted, and the motor head turned to either side, as wanted, and the screw, C, then tightened.

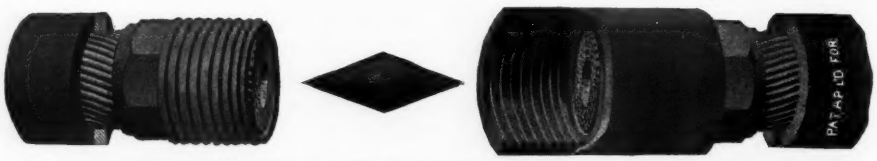


Fig. 1.—New Conical Expansion Plug Cable Jointing Device.

A New Cable Jointing Device.

The accompanying illustrations give a good idea of a new conical expansion cable joint and terminal connection which is being placed on the market by the Electric Cable Joint and Appliances Company, New York city.

These cable joints are made in several forms, each embracing the primary idea, which is to utilize a threaded flanged joint, containing an internally tapered thimble, into the ends of which the cable is slipped, the taper being such that as the end of the cable is spread a positive joint is assured.

Fig. 1 shows the cable joint or terminal, which is manipulated essentially as follows: the end of the thimble into which the cable is inserted is smaller than the opposite end, the taper being such that there is always a certainty of the cable being gripped by the sleeve. After both ends of the cable have been inserted in the thimbles and these adjusted in the flanged and threaded terminals, a small hole is started between the strands, with a nail or punch, and a soft copper plug with double conical ends is inserted between the strands at the ends of the cable. The threads are then brought together and screwed up under pressure, this action causing the soft copper plug to spread and press the strands of the cable tightly against the inner walls of the sleeve, as is shown in Fig 2. This double conical plug, being forcibly pressed into place, forms a very effective contact, and is of sufficient cross-section to carry the entire current which may be flowing through the conductor.

Fig. 2.—Completed Joint.

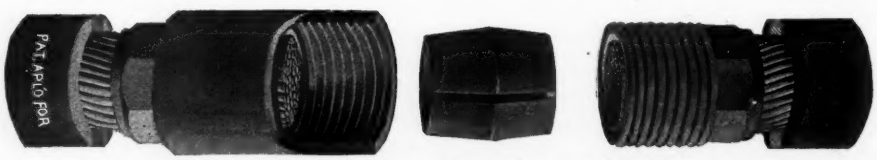


Fig. 3.—New Split Ring Cable Jointing Device.

Fig. 3 shows the sections of another form of cable terminal made by this company, which utilizes a split ring, the ends

of which are tapered so that upon the strands being brought together, the cable being inserted as previously described, the flared lips of the split ring are clamped tightly about the cable, forming an intimate and positive connection. When the threads have been tightly drawn up, the relative positions of the thimble and cable are as shown in Fig. 4.

Numerous tests have been made of the conductivity of these joints, which have resulted very favorably for the construction.

The copper terminals are of high conductivity, and the contacts are such as to secure a low resistance at the joint.

This form of terminal does away with soldering joints, and also with more or less unsightly taping, which is necessary when making stranded cable connections. There is also less danger to the insulation of the cable, and the application of the terminal is not at all limited to electrical construction.

The tests above mentioned show these joints to be of a high electrical and mechanical efficiency, and the tensile strength

FIG. 4.—CABLE JOINT COUPLER.

of the joint is in excess of that of the cable itself.

Another interesting and thoroughly practical application of this feature is in its adaptation as a cable terminal for switchboard practice. The switch may be so designed as to have, instead of the ordinary recess for the reception of the cable, a threaded end, into the butt of which may be fixed a dowel pin so arranged that when the cable has been inserted in the tapered thimble the flanged sleeve and the switch receptacle may be quickly screwed together.

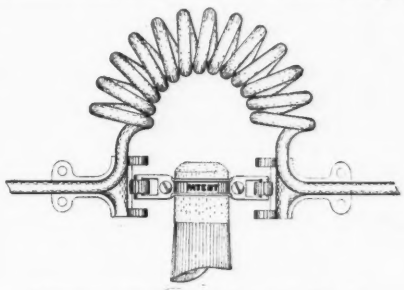
This obviates the use of a soldered connection, and eliminates the danger of ruined insulation and a number of other difficulties.

Iowa State College of Agriculture and Mechanic Arts.

The trustees and faculty of the Iowa State College of Agriculture and Mechanic Arts dedicated the new engineering hall at Ames, Iowa, on Friday, May 22. Addresses were delivered by Dr. R. H. Thurston, of Cornell University, Ithaca, N. Y.; Mr. W. Clyde Jones, of Chicago, and Mr. M. J. Riggs, of Toledo, Ohio. The dedication exercises were held at three P. M., and these were followed by a reception in the evening at eight o'clock.

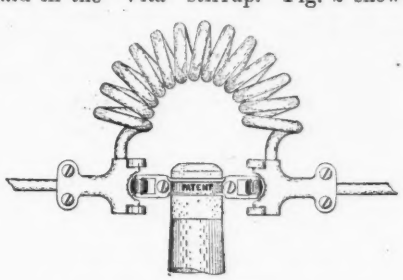
A New Construction Specialty.

The accompanying illustrations will show the application of the "Shickluna Vita stirrup." These stirrups are designed for making connections with conductors delivering current to street lamps,



STIRRUP, WITH WIRE LAID IN PLACE

or to any swinging electrical device which is liable to become open-circuited from wind motion or from mechanical operation. The general demand for a device at a reasonable cost, to supplant the old methods of tying the wires in the grooves of a glass or knob, has induced the manufacturer of this device to present this design to the market. The stirrup is made of refined malleable iron, heavily galvanized, making the device strong, light and substantial. The manufacturer states that it will positively prevent a wire from breaking where it is installed, as the cover of the wire is not removed or even scratched, and the circuit is continuous direct to the lamp. Fig. 1 shows the wire laid in the "Vita" stirrup. Fig. 2 show-



STIRRUP, WITH WIRE CLAMPED.

ing the wire clamped in the stirrup. This device is manufactured by the White Star Appliance Company, 316 Potomac avenue, Buffalo, N. Y.

Montreal Technical Institute.

A company has been inaugurated in Montreal to found a technical institute in that city. The amount of capital will be $250,000, of which $100,000 has already been donated by the Mechanics' Institute. The objects of this institute are to furnish and promote technical, artistic, industrial and commercial education. A building will be erected which will contain lecture rooms, libraries, laboratories and workshops. Instruction will be carried on by lectures and correspondence.

Conduit Exhibit at the Convention.

The Standard Vitrified Conduit Company is to have an exhibit of its conduit at the Auditorium Hotel, Chicago, Ill., during the National Electric Light Association's convention, the exhibit to be in charge of Mr. B. S. Barnard, vice-president and secretary of the company.

The new factories of this company at South River, N. J., are now in full operation, in addition to the old factories, giving an enormous daily capacity of multiple and single-duct conduit. The company has secured a large number of orders for conduit in the New England states this season, and a large part of the orders east of the Ohio River. Upward of 1,000,000 feet of conduit were purchased recently through it for Salt Lake City, Utah, by the Stromberg-Carlson Telephone Manufacturing Company. This will be shipped from the western factories, the Standard company being in a position to supply conduit in any part of the United States. Another order recently secured is for 500,000 feet for Memphis, Tenn., and a number of prominent corporations throughout the country are using its product this season in large quantities. The company is also doing a large business in third-rail insulators. The catalogue recently published is very handsome, and is replete with information on conduit construction, making it of great practical value to the engineer.

Electrical Manufacturer Organizes Under New Name.

The Christensen Engineering Company, Milwaukee, Wis., has made a change of organization. This has become a necessity through the greatly increasing demand for Christensen air brakes and "Ceco" electrical machinery. The owners of the stock of the company have organized the National Electric Company, and the assets, good will, etc., of the Christensen Engineering Company were transferred on May 16 to the National Electric Company. The purposes, ownership, management and control of the new company are identical with those of the old.

New York State Independent Telephone Association.

The third annual meeting of the New York State Independent Telephone Association, for the purpose of the election of officers for the ensuing year, and the transaction of such other business as may properly come before the meeting, will be held at the Butterfield House, Utica, N. Y., Wednesday, June 10. The meeting will convene at two P. M. Mr. George R. Fuller is the president of the association, and Mr. Charles O. Harris, 59 Stone street, Rochester, N. Y., is secretary.

New Works for Dayton Electrical Manufacturing Company.

The Dayton Electrical Manufacturing Company, of Dayton, Ohio, which has been occupying a six-story factory in the Beaver Power Block of that city, has outgrown its present quarters and is now building a large and modern plant at Miamisburg, one of the suburbs of Dayton.

During the nine years that this company has been manufacturing the "Apple" gas engine igniter, its business has been rapidly growing, and to-day, with an output of one hundred igniters per day, it is impossible to keep up with its orders.

The main building of the new plant will be 500 feet long by 60 feet wide, with four other buildings of smaller size.

The total output of the igniter department will, upon completion of the new plant, exceed two hundred complete outfits per day, and, in addition, this department will manufacture a complete line of jump and touch spark coils, plugs, switches, ignition dynamos and magnetos with governors for the same; and the King timing device for engines using the jump spark system.

The storage battery business will be handled by a separate department, and will include the building of batteries varying in weight from five pounds to four tons. The "Apple duplex" is a unique type of storage battery, in that the negative element forms the containing-jar and each cell is practically a lead bottle, completely enclosed, non-breakable and non-leaking. It was originally designed for ignition purposes, to be used in connection with the Apple dynamo, for sparking gas engines. Its lightness, compactness, capacity and durability have led to its adoption for automobile and marine propulsion, and the Dayton Electrical Manufacturing Company now intends building the same type of cells in larger and heavier sizes for stationary use.

The original Apple ignition dynamo weighed forty pounds, was unwieldy and cumbersome, with all the working parts exposed to the air and consequent dirt and dust. The latest "Apple" igniter weighs fifteen pounds, is completely enclosed, and is dust, dirt, oil and waterproof. Its output is ten volts and four amperes, ample current to work successfully any type of touch or jump spark coil.

The "Apple" magneto, which has been placed on the market to meet a demand for a medium priced mechanical igniter adapted to touch spark work, is also completely enclosed, although the working parts are easily accessible.

By purchasing the Cotton patents and adding thereto some of Mr. Apple's ideas, the company will soon be ready to market an ignition plug that it expects to have a large sale. The King timing device, the invention of Charles B. King, of Detroit, is now manufactured by this company under a royalty to Mr. King, and its adoption by many of the leading automobile manufacturers and an ever-increasing demand for the same, lead the maker to believe that its manufacture may demand a separate department in the new establishment.

A Maximum Demand Indicator.

A new form of maximum indicator has been brought out in England which possesses the advantages of simplicity and cheapness. It consists essentially of an air thermometer, having two bulbs connected by a capillary tube. The tube is placed in a vertical position in a suitable case, and the upper bulb is partially filled with mercury. The tube itself is small enough to prevent the mercury flowing into the lower bulb by gravity. The lower bulb is surrounded by a spiral of resistance wire, which is held tightly against the bulb by spring clips. These clips are so arranged that they come together and close a circuit should the spiral be broken by accident.

The action of this apparatus is as follows: The current used by the consumer must pass through the resistance and in doing so heats the air in the bulb, forcing it up through the tube into the upper bulb. When the current is shut off, the lower bulb cools down and the mercury is forced down into the capillary tube, the distance depending upon the maximum current. To readjust the apparatus, the tube is taken out and the mercury shaken down into the upper bulb and both bulbs brought to the same temperature by holding one in each hand. This takes but a minute or two, while the full effect is not produced by the current unless it has passed for at least four minutes. The apparatus is manufactured by Messrs. Fricker & Miller, 82 Victoria street, London, S. W.

Wireless Telegraphy from Moving Trains.

Experiments were made recently on the high-speed electric railroad between Berlin and Zossen with the Siemens-Braun system of wireless telegraphy. Communication was maintained during a journey of a train from Marienfelde to Rangsdorf between the train and the various stations on the line. Results are said to have been successful and reliable.

Waste Available for Fuel.

Commissioner John McGaw Woodbury, of the Street Cleaning Department, New York city, has received the reports of experts as to the experiments made in the use of street and store sweepings as fuel. He has calculated that there would be 800,000 cubic yards a year, which could be utilized by the new process in the making of briquettes for fuel. With this fuel it was estimated that power enough to light 7,272 lamps of 2,000 candlepower each for a year could be obtained.

Commissioner Woodbury will sell the fuel, and it is announced that some arrangement for the use of machinery of the city to generate and sell power for the pumping stations in the Borough of Manhattan of the Water Supply Department might be made.

Canadian Westinghouse Company.

Steps have been taken to form a Canadian Westinghouse company, it is announced, for the purpose of manufacturing in Canada the apparatus needed to supply that market. In order that its plant at Hamilton and its real estate there may be utilized the Westinghouse Air Brake Company will be included. The capital of the company will be $2,500,000, of which the Air Brake Company will have $850,000 and the electric company $950,000, the remainder of the capital stock being taken at par by Canadians, who are desirous of securing an important minority interest in this new company.

The arrangement provides for a cash working fund of $1,250,000, not including the money already invested in works and real estate.

Copper Deposits in New Mexico.

There are a number of deposits of copper ore in central New Mexico, lying east of the Rio Grande. On the eastern base of the Sierra Oscura are several low ridges containing reefs of copper ore. These overlie limestone and in turn are covered by red sandstone and shales, and may be divided into three belts; the northern, middle and southern, none of which has been exploited in depth.

Two partial analyses from selected carload lots of ore show about ten per cent of copper, and from this it is inferred that the ore will run about four per cent copper. The nearest railway station to these deposits is sixteen miles to the east, and there are coal mines within thirty-five miles. The price of coal delivered at the mines is $5.50 per ton. At Estey City an electrolytic plant has been built for treating 100 tons or more of copper ore per day, but no information has been given out of the success of this undertaking.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW TELEPHONE LINES—The Pittsburg & Allegheny Telephone Company's allied interests will expend over $1,000,000 shortly in perfecting a long-distance service to Philadelphia, Baltimore and other important points. Ten trunk lines will be run East, the main line closely following the Pennsylvania Railroad. Over 800 miles of wire will be strung, operations being scheduled to be commenced in a few days. Arrangements are being consummated with independent companies throughout Pennsylvania, West Virginia and Maryland, which will place Pittsburg subscribers in touch with 20,000 subscribers and 112 exchanges outside of Philadelphia and Baltimore. About $800,000 will be spent by the company in Allegheny County. The number of telephones will be increased to 20,000. Four direct lines will be built to reach southeastern Ohio. The new lines are to be ready for use by October 1.

MEXICAN LIGHT AND POWER COMPANY—The directors of the Mexican Light and Power Company have unanimously decided that the company should, in addition to acquiring the properties of the City of Mexico Electric Light Company, owned by Messrs. Siemens & Halske, of Berlin, acquire the properties of the City of Mexico Electric Tramway Company, which are owned by Messrs. Warner, Bite & Company, of London, England. By securing these companies, the Mexican Power Company will control the companies using the largest amount of electric power in the republic of Mexico. This Mexican company is the first company ever formed in which the leading interests of all the leading Canadian banks and corporations have become indentified. Among the largest stockholders are the leading interests of the Bank of Montreal, the Canadian Bank of Commerce, the Canadian Pacific Railway, the Grand Trunk Railway, the Canadian Northern Railway, the Dominion Iron and Steel Company and the Dominion Coal Company.

BIG POWER PLANT ASSURED—A company has been incorporated under the laws of New Jersey and has organized, with Charles L. Flint, of Boston, as president, Charles H. Maxey, of New York, as vice-president, and Daniel D. Gile, of Boston, as secretary and treasurer, to develop more electrical power on the Farmington River, Massachusetts. The company intends to dam back the water in the Farmington River south of Cold Spring in the town of Otis and carry it about five miles in a concrete or steel pipe eight feet in diameter to the C. D. Case school furniture factory south of New Boston, where a power plant will be erected. If necessary, the company will also dam the river at that point. The company has had good offers for all the power which it would have in Springfield and Worcester, but it is said it will look out for the interests of the proposed trolley road from Lee to Winsted; in fact, the promoters will aid the latter project as best they can. Their power will take a capital of about $1,000,000. It is not known when work will be begun.

CANADIAN MUNICIPAL POWER PLANT—Mr. Rust, Toronto city engineer, has submitted a short report to the Toronto Legislature regarding electrical energy and the cost of a generating station at Niagara Falls with a capacity of 35,000 horse-power, a transmission line to Toronto, and distributing agencies in the city. His figures are as follows: Generating, from $4,000,000 to $6,000,000; transmission, $1,000,000, and distribution, $185,641, making a total approximately from $7,000,000 to $9,000,000. A bill has also been introduced in the Canadian Legislature to enable municipalities to go into the business of supplying electrical energy. An exception has been taken to this bill because of a clause which empowers the chief justice of Ontario to appoint the commissioners who are to have charge of the work. Under these conditions the municipalities would be shorn of their power, and the opinion is held that wherever a municipality desires to go into business, it should have the power to appoint the commissioners.

CANADIAN ELECTRIC RAILWAY MERGER—An important electric railway merger, on the lines of the International Railway Company, is planned for the Canadian side. Its operations will cover Toronto, Hamilton, St. Catherine's and Niagara Falls, Ontario, and its lines will also reach Buffalo. The existing roads to be allied in the new scheme are the Niagara, St. Catherine's & Toronto, Hamilton Radial, Hamilton, Grimsby & Beamsville, Hamilton Street Railway, Toronto & Mimico, Toronto Suburban, and Metropolitan, of Toronto. A bill has been introduced into the Canadian Parliament to incorporate the Toronto & Hamilton Railway Company, with a capital of $1,500,000, with power to make running arrangements with any or all of the above-named roads, or to buy their lines, franchises and equipments. The franchise asked for also includes telephone, telegraph and steamship clauses, enabling the company to buy or build lines for communication around, across or under Lake Ontario to the Niagara district. The railway links to connect existing lines would be a few miles between Toronto and Hamilton, a stretch from St. Catherine's to Beamsville, and a line from Niagara Falls, Ontario, to Buffalo.

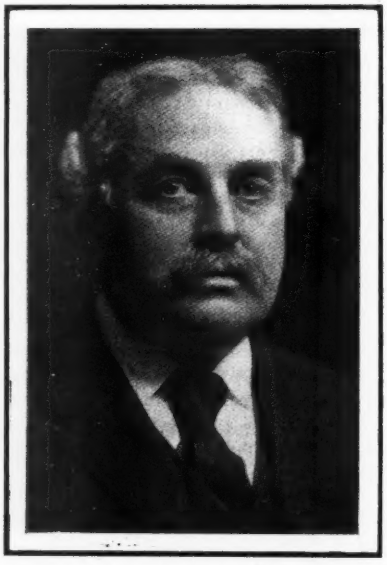
A NEW INTERURBAN RAILROAD SYNDICATE—It has been announced in Washington, Pa., that the officials who closed the deal for merging the Washington and Canonsburg railway interests have planned a combination of street railway lines between Pittsburg and St. Louis. This merger will be a very extensive one, and it is stated will be under the control of the Widener-Elkins interests, involving a capitalization of something more than $100,000,000. The four principal companies to be merged are those of Pittsburg, Columbus, Indianapolis and St. Louis, while those of Washington, Wheeling, W. Va., Newark and Zanesville, Ohio, and other smaller cities will be included. The proposed road will be a direct one between Pittsburg and St. Louis, and will be about 750 miles long. The negotiations for combining the street railway capital to form the inter-city road have been under way for about two years. The new road from east to west will avoid the larger cities and towns as much as possible, on account of the high-speed which it is expected to maintain, and the suburban lines will all be feeders to the main through line. Fast express trains of three and four cars will be operated between Pittsburg and St. Louis, and it is believed will compete actively with other railroad systems. The rights of way, where roads are not already in operation, have been obtained. The Washington & Canonsburg Railway Company was taken over by the new company at $1,500,000, the merger to take place shortly. It is the intention of the new combination of capital to build a branch line from Indianapolis to Chicago, with other roads radiating from various important centres.

ANOTHER CONNECTICUT POWER COMPANY—A favorable report has been presented to the Connecticut Legislature from the committee on incorporations, on the franchise of the Eastern Connecticut Electric Power Company. The main financial backing of this company is said to be furnished by R. E. Hawks, of Boston, and associates, and the management of the company is to be by Perkins & Perkins, Hartford lawyers. Among others interested in tne company, as announced, are R. L. Warner, State Senator F. E. Jacobs, Harry E. Beck, Harold Lawton and Clinton F. King. The Eastern Connecticut Electric Power Company is given power by its charter to purchase, lease or sell lands, rents, tenements, franchises, hereditaments, mills, manufactories, water rights and mill sites, and to do all kinds of general electric business, generate electricity, distribute it, and deliver it in Wyndham County, and in the towns of Sprague, Franklin, Lisbon, New London County, and to extend these plants into Massachusetts. The company is also to have the right to manufacture and sell wool, cotton, iron, paper and other materials or products of mixed materials. It is to have an initial capital stock of $100,000, with power to raise that amount to $900,000. The company has three possible sites under consideration for the main power dam, but the selection has not been announced as yet. The company will build a dam, generate electricity, and sell this power to existing manufactories; build new manufactories of its own, and operate them by electricity; transmit electric power to existing street railroads in the section, and in the near future build trolley lines of its own.

OBITUARY NOTICES.

MR. EZRA TORRANCE GILLILAND.

The ELECTRICAL REVIEW mentioned briefly in last week's issue the death of Mr. Ezra Torrance Gilliland, which occurred at Pelham Manor, N. Y., at four o'clock, Wednesday morning, May 13, a few hours before we went to press. His death was caused by heart failure, brought on by an acute attack of Bright's disease, from which he had been a sufferer for three or four years, although this was known to only a very few of his friends. Mr. Gilliland was one of the pioneers of first rank in telephone work. He was one of the few to whom the idea first came of the possibilities of the exchange telephone service, now so universally adopted in all parts of the civilized world. He was an original worker in inventing and manufacturing telephone switchboards, magneto call bells, and other appliances required in a central telephone office and at the subscriber's instrument. His first work was done in Cincinnati. Afterward he established a manufacturing company in Indianapolis, and from there formed an alliance with the Western Electric Company, at Chicago, now probably the greatest electrical manufacturing and supply company in the United States, and which still turns out apparatus under the Gilliland patents. Mr. Gilliland was active also in organizing and consolidating a number of telephone operating companies, and was at one time president of several of these in the middle and western states. His faith in the great future demand for the telephone never faltered, and in his day there was probably no one man who did more for its development. Mr. Gilliland was also an able mechanician, and took great delight in working with machinery and tools. He was associated with Mr. Edison for a number of years, in developing the induction telegraph and the phonograph. They had previously been thrown together as telegraph operators, in which field they both were experts. About 1884 Mr. Gilliland moved to Boston, and spent a few years at the head of the experimental department of the American Bell Telephone

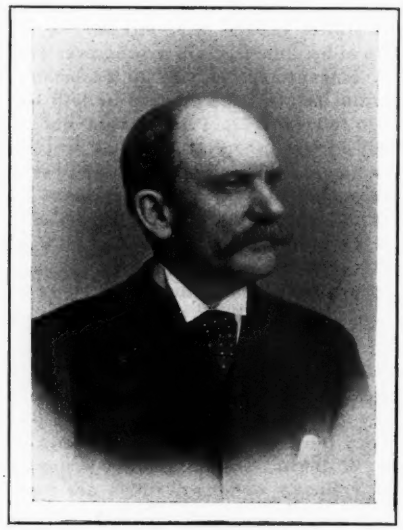


MR. E. T. GILLILAND.

Company, subsequently removing to Pelham Manor where he built and operated a fine laboratory and where he resided until the time of his death. Until within the last year or two he was on the staff of the American Bell Telephone Company as one of its recognized electrical experts. Mr. Gilliland was elected president of the village of Pelham Manor, and served several years, and was highly esteemed by that most excellent community. Mr. Gilliland was the possessor of a great many friends, and his death will bring sorrow to the hearts of many of the men eminent in electrical circles, particularly in the telephone and telegraph fields, where all honored his abilities, and respected and loved the man. The funeral services were held at his late residence in Pelham Manor, Friday afternoon, and were attended by the leading citizens of that beautiful village, and a number of electrical friends. The body was interred at Adrian, Mich.

MR. WILLIAM BROOKFIELD.

Mr. William Brookfield, a prominent manufacturer of glass products for electrical use, died at his home, 516 Madison avenue, New York city, on May 12. Mr. Brookfield was taken sick while at Palm Beach, Fla., and was brought home about six weeks ago. He was born



MR. WILLIAM BROOKFIELD.

at Greenbank, N. J., May 24, 1844, where he was educated, moving to Brooklyn in 1862. It was here that he became engaged in business which has subsequently become known as the Brookfield Glass Company, manufacturer of electrical glass specialties, particularly glass insulators for high-tension transmission circuits, of which company he was president. Mr. Brookfield was a prominent citizen, and deeply interested in both city and state politics. He was greatly admired by his party associates, and was at the head of the Republican State and County committees from 1891 to 1894. He was appointed Commissioner of Public Works by Mayor W. L. Strong, and was a prominent member of all the important state conventions since 1875. Mr. Brookfield was one of the most influential in bringing about the present primary law. In addition to his political affiliations, he was prominent socially, being president of the St. John's Guild, and trustee of Wells College, at Aurora, N. Y. He was a member of the Chamber of Commerce. Board of Trade and Transportation, the Consolidated and Mining exchanges and the Produce Exchange, besides being in the directory of several insurance and other industrial corporations. He is survived by his wife, who was Miss Kate Morgan, of Aurora, N. Y., and four sons.

ELECTRIC LIGHTING.

ANDERSON, IND.—The city lighting plant is to be enlarged at a cost of $75,000.

GREENSBURG, IND.—A ten-year franchise has been granted to the Greensburg Electric Company by the city council, to take effect April 1, 1904.

LOS ANGELES, CAL.—The San Bernardino Electric Light and Power Company has passed into the control of the Pacific Light and Power Company.

PUT-IN-BAY, OHIO—A franchise has been granted to R. K. Ramsay for the construction and operation of a plant for furnishing electricity for light, heat and power.

LANCASTER, WIS.—The Lancaster electric light plant, owned by John G. Harshburger, has been sold to a local syndicate composed of John Schreiner, R. B. Showalter, Joseph Bock, R. Meyer, Jr., J. G. Harshburger, C. H. Baxter, H. W. Brown, Frank Schreiner and George Badter, which has made application to the city for an extension of franchise. The new company will improve the plant, expending something like $50,000.

ELECTRICAL SECURITIES.

Following the tendency which has been evident for the past several weeks, the market closed with more or less of a decline in prominent securities. With this decline, however, there has been no apprehension of serious consequences; and the sag seems to be the result of apathy, rather than any timidity on the part of speculators. The drop in prices now begins to be looked at as an opportunity of inaugurating a strong buying policy, and it needs but an initial movement to stimulate a hearty activity in many directions.

The outlook which existed a week or two ago for a general evidencing of dissatisfaction by labor organizations throughout the country is not being borne out, and the possibilities are now regarded as being favorable for a continued peaceful condition of affairs.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 16.

New York:	*Closing.*
Brooklyn Rapid Transit	64
Consolidated Gas	204¼
General Electric	187½
Kings County Electric	200
Manhattan Elevated	140
Metropolitan Street Railway	129⅝
New York & New Jersey Telephone	164
Westinghouse Manufacturing Company	200¼

The Kings County Electric Light and Power Company has declared a quarterly dividend of 2 per cent, an increase of ½ per cent over the previous payment. This places the stock on an 8 per cent basis. The dividend is payable June 1. Books close May 22 and reopen June 1.

The general balance sheet of the Manhattan Elevated Railway Company, as of March 31, shows total assets of $105,785,911, and total liabilities of $98,683,139, leaving a surplus of $7,102,772.

A circular has been issued by the Westinghouse Electric and Manufacturing Company announcing that stockholders will have the privilege of subscribing to $4,500,000 par value of new stock, at the rate of $80 per $50 share. This offer applies to stock of record of May 23, and subscriptions must be made not later than June 8.

Boston:	*Closing.*
American Telephone and Telegraph	155
Edison Electric Illuminating	272
Massachusetts Electric	87
New England Telephone	136
Western Telephone & Telegraph preferred	95

The American Telephone and Telegraph Company's instrument statement for the month ended April 30, and since December 20, shows the total number of instruments outstanding to be 3,400,573, as compared with 2,671,720 for the same period last year.

Philadelphia:	*Closing.*
Electric Company of America	8⅞
Electric Storage Battery common	74
Electric Storage Battery preferred	74
Philadelphia Electric	6⅞
Union Traction	46
United Gas Improvement	90⅝

United Gas Improvement was subjected to a continuation of the selling pressure, and closed with a net loss for the week of 4⅜.

The balance sheet of the Philadelphia Electric Company, as of December 31, 1902, shows accrued earnings of $2,450,580.

Chicago:	*Closing.*
Chicago Telephone	142
Chicago Edison Light	154
Metropolitan Elevated preferred	72
National Carbon common	24½
National Carbon preferred	95½
Union Traction common	4
Union Traction preferred	32

The extension improvements to be made to the South Side Elevated Railroad will cost $4,950,000. Construction will begin in August, and the work will be finished within three years.

The balance sheet of the Chicago Edison Company, as of December 31, 1902, shows total assets of $15,539,365, and total liabilities of $14,929,281, leaving a surplus for the year of $610,084, as compared with a surplus of $431,077 for the preceding year.

PERSONAL MENTION.

PROFESSOR F. B. BADT, of Chicago, the eminent electrical engineer and author of the Badt "Hand Books of Electricity," is spending a fortnight in New York city.

MR. CHARLES R. HUNTLEY, Buffalo, former president of the National Electric Light Association, was a New York visitor last week, calling on electrical and non-electrical friends.

MR. PERCY H. THOMAS, Pittsburg, Pa., will deliver a lecture on "Static Discharges on Electric Circuits," on May 28, before the Franklin Institute of the State of Pennsylvania, of Philadelphia, Pa.

MR. WILLIAM J. HAMMER delivered a lecture before the New York Electrical Society on Wednesday evening, May 20, on "The Phenomena of Radio-Active Substances, Radium-Polonium, Actinium and Thorium, Phosphorescence and Phosphorescent Substances."

MR. JAMES B. CAHOON has resigned as secretary and treasurer of the National Electric Light Association. Mr. Cahoon, who has been an earnest advocate of the best interests of the association, of which he was at one time president, has been compelled to take this step on account of continued ill health.

PROFESSOR E. R. VON NARDROFF, of Erasmus Hall High School, Brooklyn, N. Y., is announced to deliver a lecture before the Cooper Union Chemical Society, upon "The Properties of Inaudible Sound Waves," in the chemical lecture room, Cooper Union, Third avenue and Eighth street, New York city, on Saturday evening, May 23, at eight o'clock.

MR. FRANK G. BOLLES, chairman of the Ohio State Committee on the Standardization of Literature, has issued a booklet making a plea for the standardization of advertising literature. The advantage which manufacturers would gain if their advertising literature were so proportioned that permanent files could be preserved, is worthy of serious consideration by any one who devotes any expenditure for publicity.

MR. FRANCIS GRANGER, the well-known sales representative of New York city, has found it necessary to remove from his suite of rooms in the Havemeyer Building to larger quarters on the floor above. Mr. Granger's new offices are commodious and convenient of access, and he will be pleased to greet his friends and patrons at all times. One of the prominent specialties which Mr. Granger is the New York agent for, is the Sterling lamp, made by the Sterling Electric Manufacturing Company, of Warren, Ohio.

MR. WALTER B. SPELLMIRE has been appointed district manager of the Atlanta office of the Bullock Electric Manufacturing Company, Cincinnati, Ohio. He will assume his duties at once with headquarters in the Empire Building of that city. Mr. Spellmire has been with the Bullock company some seven or eight years, during which time he has filled the position of chief of the testing department, after which time he was sent to London and Paris by the company to look after some important installations at these places. After being abroad one year, he returned to the United States to fill the position of sales engineer in the New York office, from which position he has just been appointed district manager. From a knowledge of Mr. Spellmire's work with the Bullock company, it is only fair to presume that he will attain success in his present position in which he will have a very much broader field of operation. He makes friends readily and always impresses a charming personality on those with whom he comes in contact.

INDUSTRIAL ITEMS.

MR. F. F. PROCTOR, proprietor of the Proctor circuit of theatres, is a firm believer in and an exponent of the electric fan as a medium for the proper ventilation of theatres. The Twenty-third Street Theatre, New York city, is now being fitted with a system of cold storage pipes which will be used in conjunction with the blower system to ensure a cool house even on the warmest days during the summer. Not only in the ventilating departments are the Proctor theatres conspicuous, but the lavish use of electrical appurtenances in other directions makes all of the theatres in this circuit very enjoyable to the many patrons of the Proctor enterprises.

THE AMERICAN PUSH BUTTON TELEPHONE COMPANY has taken new offices in the Electrical Exchange, 136 Liberty street, New York city. This company reports a great deal of new business.

including an order for $3,000 worth of telephones from a prominent railway company. Mr. W. V. Sweeten, manager of the company, is planning a trip, beginning on June 1, as far west as the coast. This trip will be made in the interests of the new type of telephone which this company is placing on the market, and which it claims offers many advantages over the older styles.

JULIUS ANDRAE & SONS COMPANY, Milwaukee, Wis., local agents for the Nernst Lamp Company, have recently sold to the city of Oshkosh, Wis., a supply of Nernst lamps for street illumination. The Sewickley Electric Light Company has also entered an additional order for twenty six-glower lamps, which are to be used in extending the street lighting system of the town of Sewickley, Pa.

THE ROPE FIBRE PULLEY COVERING COMPANY, Springfield, Ohio, is placing on the market a substitute for pulley dressing for which great merit is claimed. This pulley covering is said to prevent belts from slipping, and will also absorb oil from greasy belts. The material is not in any way a belt dressing, but is a practical rope fibre which is applied so as to cover the pulley, and this application can be accomplished without any special tools in a very short time. Large pulleys can be covered without removing the belt. Another claim made by the manufacturer is that the material may be applied to either a new or old pulley, whether of iron, wood or other material.

THE SHERWOOD MANUFACTURING COMPANY, Buffalo, N. Y., is distributing its new catalogue devoted to the leading articles of its manufacture for engines and boilers. This describes and illustrates injectors, ejectors, oil cups, multiple oilers, oiling devices, lubricators, boiler oil injectors, oil pumps, grease cups, flue scrapers and blowers, gauge cocks, three-way cocks, pressure gauges, water gauges, pop valves, hose connections, and steam carriage and automobile specialties. The catalogue is carefully indexed, and the illustrations and diagrams are well worked up. This catalogue may be secured from the Sherwood company, on application to its Buffalo headquarters, 34 and 36 Washington street.

THE SIMPLEX ELECTRICAL COMPANY, Chicago, Ill., has removed to more commodious quarters at 1144 and 1146 Monadnock Block. The warehouse has been moved to the northwest corner of Dearborn and Harrison streets. For the convenience of city customers calling with written orders, deliveries will hereafter be made direct from the warehouse, without the necessity of calling at the office. Mail orders and enquiries should be addressed to the office as usual. These changes, necessitated by the growth of the business, will give the company increased facilities, both in the offices and warehouse, and enable it to carry a larger and more varied stock of all kinds of rubber-covered wires and cables, lead-covered cables, telephone wires, weather-proof wires, etc.

THE COLUMBUS STEEL ROLLING SHUTTER COMPANY, Columbus, Ohio, announces that the F. P. Smith Wire and Iron Works, 100 and 102 Lake street, Chicago, Ill., manufacturer of ornamental and structural iron, art brass and wire work, has been appointed sole agent in Chicago and several states adjacent thereto. Agencies are being established in all of the large centres as fast as desirable representative firms in architectural or engineering construction work can be found. This has been made necessary by the large number of enquiries coming from all over the United States and foreign countries, from engineers, architects and builders who have been impressed with the unique improvements in the material manufactured by the Columbus Steel Rolling Shutter Company.

THE CHRISTENSEN ENGINEERING COMPANY, Milwaukee, Wis., has found it necessary to provide increased office facilities in Chicago, Ill. In consequence of this, a large office, fully equipped with every convenience, has been opened in the Old Colony Building, where representatives of both the air brake and electrical sales departments will be pleased to welcome the customers and friends of the company. Mr. Charles G. Burton, manager of the Chicago agency for the sale of the company's "Ceco" electrical machinery, has removed from the Merchants' Loan and Trust Building into the new office. The air brake department is in charge of Mr. J. E. Eldred, Jr., who is well known in the electrical railway field, having for a considerable time represented the company in the sale of air brake equipments.

THE BUREAU OF EXPERT INVESTIGATION AND CONSTRUCTION has been organized to undertake the critical examination and valuation of properties and projected enterprises, covering the investigation of corporate charters, franchises, patents, etc.; the conducting of tests; the preparation of plans and specifications for all classes of work; the supervision of contracts and the organization and management of properties. Mr. James Blake Cahoon, 35 Nassau street, New York city, is the director of the bureau. The electrical and mechanical engineers are: Horatio A. Foster, Frank B. Rae, George T. Hanchett and Thorburn Reid. The hydraulic engineers are: George W. Birdsall and Ira H. Carpenter. The civil and mining engineers are: M. H. Alberger and Walter A. Calhoun. The chemist is Dr. William McMurtrie. The counsel are Cecil Campbell Higgins and Joseph T. Brown, Jr. The experts on patents and patent laws are Howard P. Dennison and Thomas J. Johnston.

THE EMPIRE WIRE COMPANY, which was organized about one year ago and took over the business of C. M. Garrison, Spargo Wire Works Company and Empire Insulated Wire Company, all of 100 William street, New York city, the latter two having factories at Rome, N. Y., has found it necessary to increase its capacity for the manufacture of magnet wire in order to handle its rapidly growing trade. To do this it has taken over the mill of the Granite State Electrical Works, at Lisbon, N. H., which has been thoroughly remodeled and equipped with new and modern machinery and placed in charge of a man who has been assistant superintendent for the Empire Wire Company and the Empire Insulated Wire Company for several years. The company is now turning out from this mill a wire, the quality of which is equal to that which they have heretofore made at their old factories. To look after the requirements of its western trade, the company has opened an office and stockroom at 60 West Van Buren street, Chicago, Ill., in charge of Mr. A. D. Forney. On May 1 the general offices of the company were moved to 92 William street, New York city.

R. D. WOOD & COMPANY, Philadelphia, Pa., have issued a very fine catalogue descriptive of Mond gas producers. This company constructs gas producers and producer gas power plants. The catalogue is well illustrated, and describes the constituents of Mond gas, illustrates standard Mond gas apparatus, describes some of the advantages of using this product; the process of production of Mond gas and the recovery of ammonia therefrom; practical working figures of gas installations; the use of Mond gas in gas engines; tables of results recorded; steam raising by the exhaust gases from gas engines; a list of builders of large gas engines; a chapter on Mond gas for distribution from central stations; a chapter on Mond gas for central electric stations, and articles under the following heads: "Economy of Gas Engines for Central Stations;" "Working Estimate of a 20,000 Electrical Horse-Power Central Station;" "Gas Engines for Driving Dynamos;" "Gas Engines Running Alternators in Parallel;" "The Northwich Electric Supply Company;" "The Trafford Power and Light Supply Company;" "Mond Gas for Steel Making," and "Sulphate of Ammonia."

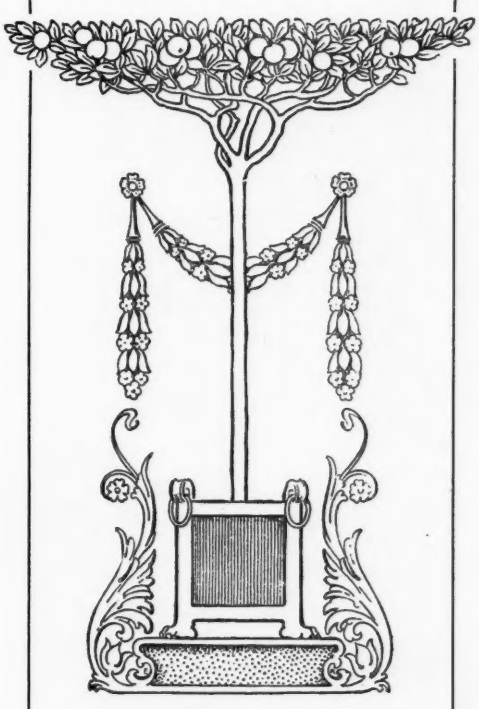
THE LOOMIS-PETTIBONE COMPANY has removed its New York office to Nos. 52 and 54 William street, New York city. The new telephone number is 202 John. The company has recently increased its capitalization to $2,000,000, and is about to begin the construction of a large plant near New York, for the manufacture of gas engines in large units, in addition to the Loomis-Pettibone gas apparatus, which the company will continue to manufacture as heretofore. The officers and directors of the company are: Benjamin Guggenheim, president; Cyrus Robinson, first vice-president and general manager; Burdett Loomis, Jr., second vice-president and manager sales department; Leon P. Feustman, secretary and treasurer; Burdett Loomis, Sr., consulting engineer; Hawley Pettibone, chief engineer; Charles E. Finney. The company is now prepared to enter into contracts for the equipment of complete plants, gas generators, gas engines, and electric generators and motors. Until its own plant is ready to turn out large gas engines, it will deliver the engines manufactured by Crossley Brothers, Limited, Manchester, England, as the company has the exclusive agency for these engines in North America. The company has recently closed contracts for a number of power plants, both in the United States and in foreign countries.

THE LOUISIANA PURCHASE

Exposition

ST. LOUIS, MISSOURI

1904



PROGRESS OF
CONSTRUCTION WORK ON
EXHIBIT PALACES
MAY 15, 1903

VIEWS OF
THE EXPOSITION,
THE CROWNING EVENT
IN THE HISTORY
OF THE
LOUISIANA PURCHASE

SEE LAST PAGE OF SUPPLEMENT FOR
EXPLANATION OF ENGRAVINGS

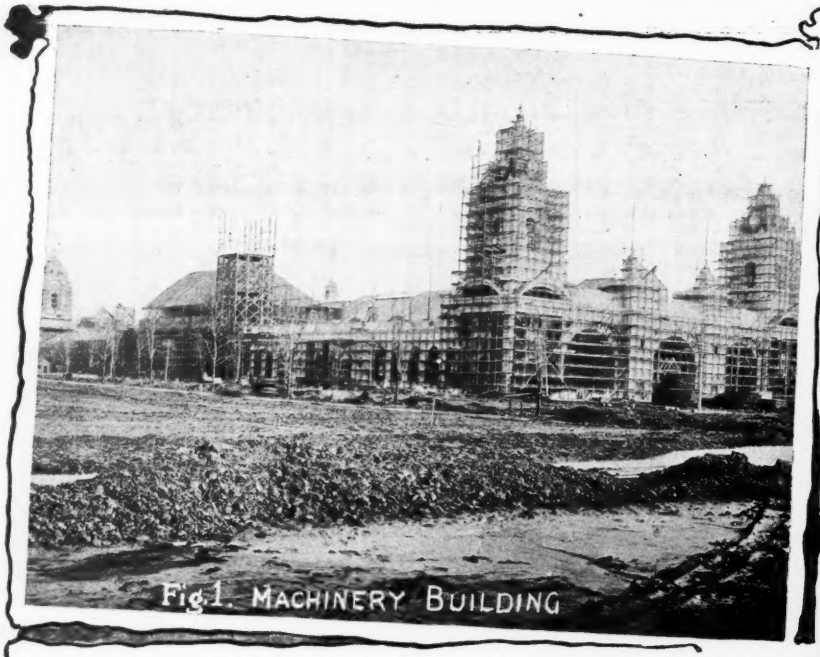


Fig.1. MACHINERY BUILDING

FIG.4. GENERAL VIEW ELECTRICITY BUILDING

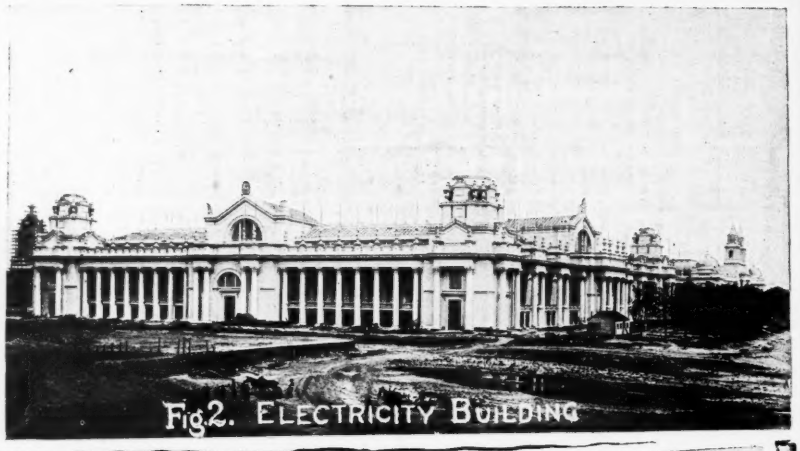


Fig.2. ELECTRICITY BUILDING

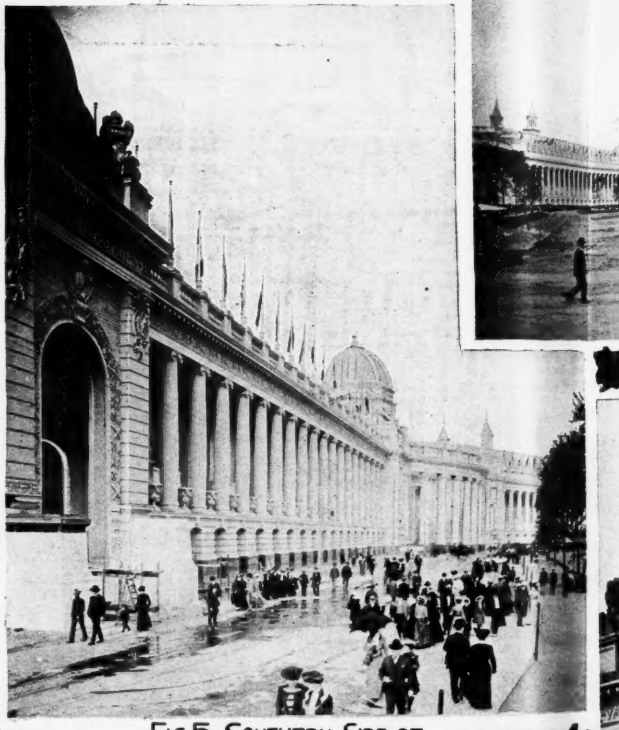


FIG.5. SOUTHERN SIDE OF VARIED INDUSTRIES BLDG.

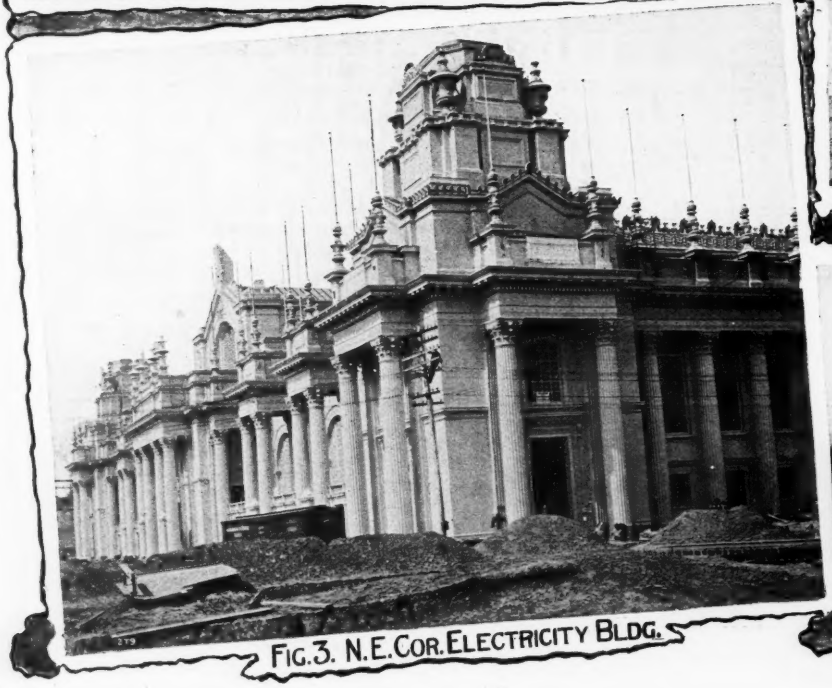


FIG.3. N.E.COR.ELECTRICITY BLDG.

FIG.6. S.E. CORNER OF VARIED INDUSTRIES BLDG.

LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO.—TWELVE VIEWS SHOWI

FIG. 7. HALL OF CONGRESSES

FIG. 10. EDUCATIONAL AND SOCIAL ECONOMY BLDG.

FIG. 8. N.W. CORNER ELECTRICITY BLDG.

FIG. 11. COURT OF ELECTRICITY BLDG.

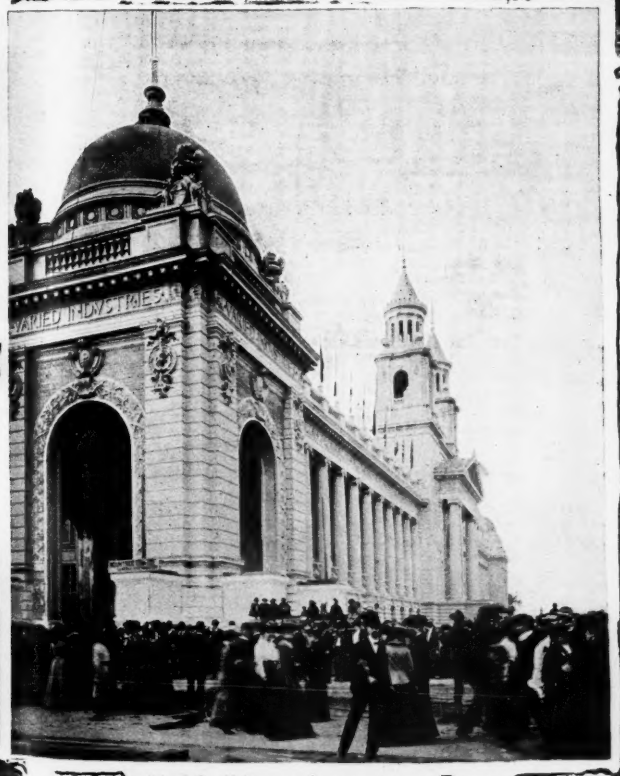


FIG. 9. VARIED INDUSTRIES BLDG.

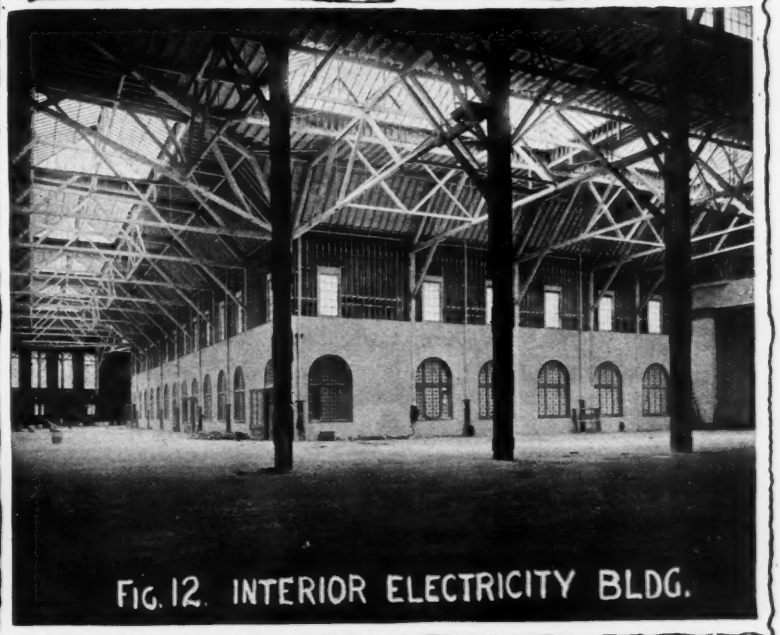


FIG. 12. INTERIOR ELECTRICITY BLDG.

SHOWING PROGRESS OF CONSTRUCTION, EXHIBIT PALACES, MAY 15, 1903.

Louisiana Purchase Exposition

St. Louis, Missouri, 1904

List of Illustrations

Number 1—View of the northeast corner of the Machinery Building. This building will contain all direct-connected electric generating sets; aggregate power developed at present arranged for exceeds 35,000 horse-power.

Number 2—View of the south and east facades of the Electricity Building, taken from the summit of Cascade Hill; towers of the Varied Industries Building on the right. The Electricity Building covers seven acres.

Number 3—View of the northeast corner of the Electricity Building showing the architectural detail. This is one of the most highly ornamented buildings on the Exposition Grounds; the towers and other prominent points will be capped by groups of statuary allegorical of electricity.

Number 4—View showing the Electricity Building on the left, the Varied Industries Building in the centre, and the Education Building on the right. View is taken from the eastern end of Cascade Hill, and the space between the Electricity Building and Education Building will be occupied by the Grand Basin.

Number 5—View of the southern side of the Varied Industries Building during Dedication Week.

Number 6—View of the southeast corner of the Varied Industries Building. This building has an area of fourteen acres, and cost $620,000. It is one of two buildings occupied by the Department of Manufactures.

Number 7—View of the Hall of Congresses, in which will be held the International Congress of Electricians. This building is on the Exposition Grounds; it is a prominent structure and is far removed from all disturbing noises; it will ultimately be a library building of the Washington University.

Number 8—View of the northwest corner of the Electricity Building showing the excavation for the lagoon between the Electricity and Varied Industries Buildings.

Number 9—View of the southeast corner of the Varied Industries Building during Dedication Week.

Number 10—View of the southeast corner of the Education and Social Economy Building. This is the first building ever devoted to education at an exposition. It stands on the eastern side of the Grand Basin, Electricity Building being on the western side.

Number 11—View of the southwest corner of the Court of the Electricity Building, showing the colonnade which encircles the Court.

Number 12—View of the interior of the Electricity Building. This building is very light and free from objectionable secluded areas. The floor of the building rests on a firm clay foundation, there being no excavation beneath the floor.